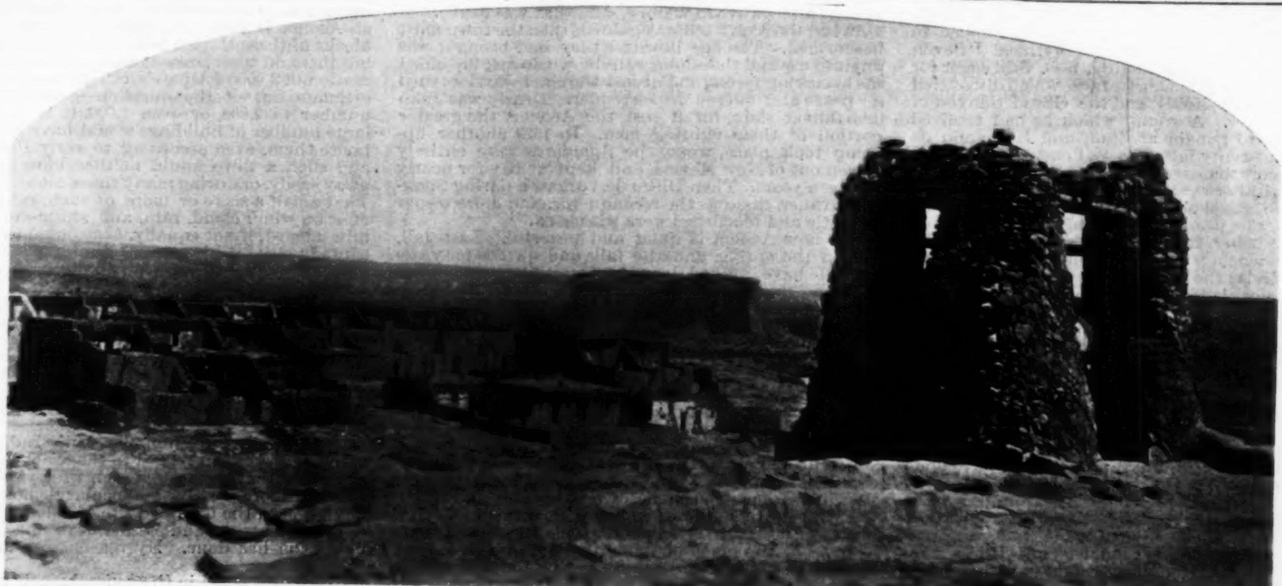
SCIENTIFIC AMERICAN SUPPLEMENT. No. 1216

Scientific American, established 1845.
Scientific American Supplement. Vol. XLVII. No. 1216.

NEW YORK, APRIL 22, 1899.

Scientific American Supplement. $5 a year.
Scientific American and Supplement. $7 a year.

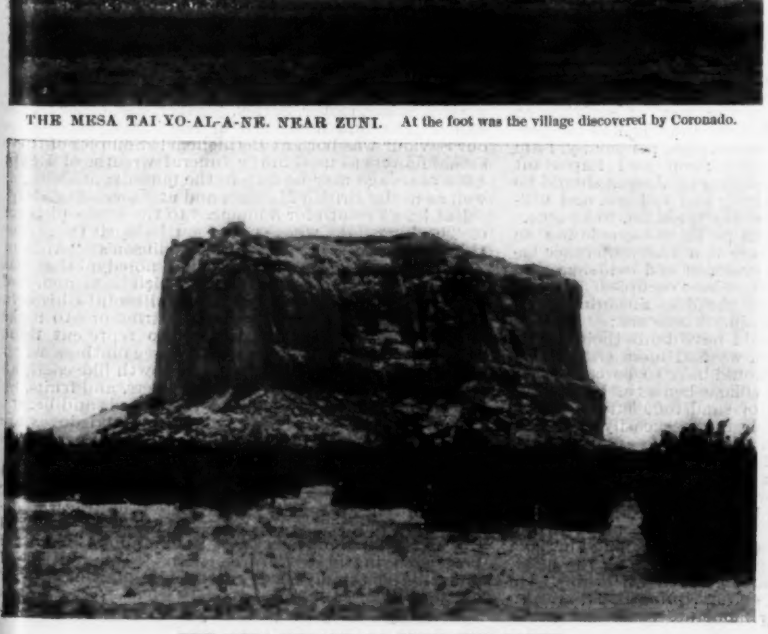


A GENERAL VIEW OF ACOMA, SHOWING TOWER OF OLD CHURCH AND THE MESA ENCANTADA.

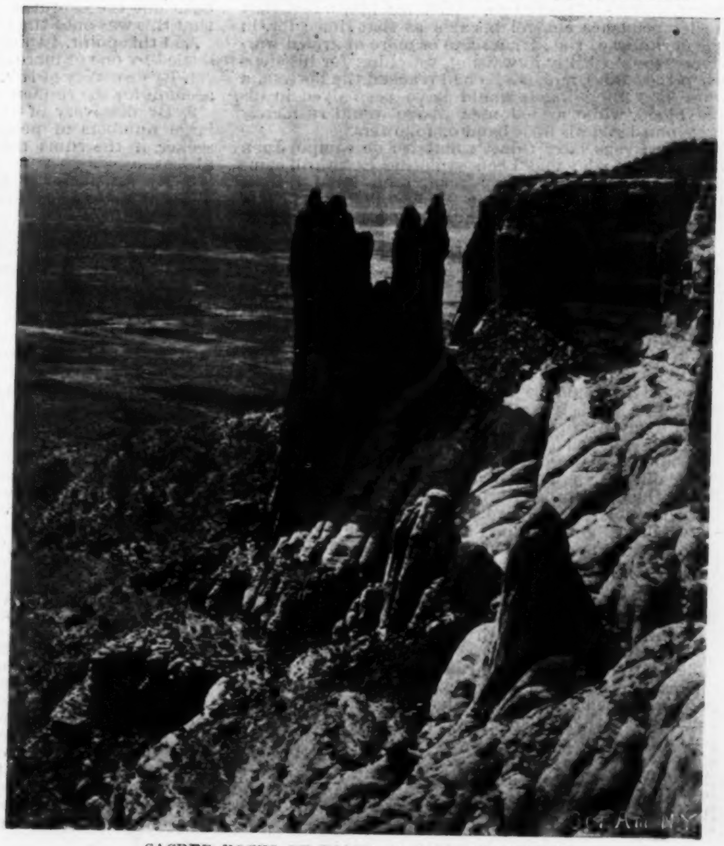
OLD ACOMA CHURCH FROM FOOT OF MESA.

HEWN SANDSTONE WALL, CIBOLLETA MESA, NEW MEXICO.

THE MESA TAI-YO-AL-A-NE, NEAR ZUNI. At the foot was the village discovered by Coronado.



THE MESA ENCANTADA FROM THE NORTH.



SACRED ROCKS ON TAI-YO-AL-A-NE, NEAR ZUNI.

PICTURESQUE NEW MEXICO.

ACOMA AND THE ENCHANTED MESA.

By G. WHARTON JAMES.

THERE is a wonderful fund of fascinating lore connected with our Southwest, that, as yet, has been but cursorily explored. The ancient history, mythology, and traditions of the Pueblo Indians, their folk lore, their ceremonies, their songs, are all as full of interest to the student as the myths of Greece or the lore of ancient Italy. Then, too, when the scenic qualities of the country are considered, the vast deserts, the glorious, snow-crowned mountains, the majestic forests, the mysterious canyons, the inaccessible mesas, the varied rock carvings of nature, all these, and many others, our Southwest becomes a region of extraordinary fascination and unusual profit to the student.

And few places repay investigation and observation better than Acoma, the City of the Cliffs. Here is an island Gibraltar, but without any circumscribing ocean. In the heart of a beautiful valley stands this wonderful rock, upon which the Tuéres people, centuries ago, established their pueblo. To the world of white men it was discovered by Coronado, just after his great disappointment at Zuni, where he had hoped to find the stored-up wealth of the mythical "Seven Cities of Cibola." This was in July, 1540. Still eager for gold he sent an expedition northward, which discovered the Snake Dancing Mokis and the Grand Canyon of the Colorado River. A wound which he had received compelled him to remain at Zuni, and Hernando de Alvarado with twenty men was sent eastward to investigate the rumors that were rife about remarkable cities to be found thitherward. In five days after leaving Zuni, Alvarado gazed on Acoma—the first white man ever dazzled by its peerless situation. Never since has an intelligent being stood at the base of those cliffs without experiencing deep and uncontrollable emotions. Casteñada, the historian of Coronado's expedition, says Acoma is situated upon "a perpendicular rock," and that is true, but, like some later writers, he stretched the truth more than a little when he said that the only way to reach the summit was by means of a stairway of three hundred steps, hewn out of the solid rock.

In general appearance there is no doubt that the cliffs of Acoma were just the same when Coronado's forces saw them as they are to-day, but in our photograph (Fig. 1) the addition of the more recent church will be noted. Walk around this mesa, as I have done many times, and enjoy the rocky sculpturings and the striking mural faces it presents. All around, it is inaccessible, impregnable, except where the four trails constructed by the Tuéres have made its ascent possible. Towers, buttresses, battlements, bridges innumerable stand in conscious majesty as nature's guards to the home of this quiet and peaceful people.

And yet not in Coronado's day, but later, it saw many and dreadful scenes of bloodshed. For, fifty-eight years after Alvarado's advent, and long after Coronado and his expedition had returned, disheartened and discredited, to Old Mexico, Juan de Oñate, the real conqueror of Arizona and New Mexico, came to receive anew the submission of the people of this "City of the Cliffs." Treachery was in the hearts of the principals when they solemnly pledged themselves to be true and submissive vassals to the crown of Spain. They were diplomats of an early American era. To them, the end justified the means, and lies and treachery were legitimate weapons in dealing with hostile forces of such overwhelming power.

Having subscribed to the oath, the Acomas invited Juan de Oñate to climb the steep and perilous trails and visit the city whose submission he had received. After gazing upon its scenes of interest, he was taken to the head of a ladder, which led into the depths of one of the underground ceremonial chambers, termed kivas by the Indians, but afterward named estufas, or stoves, by the Spaniards, on account of their stifling heat. Would he go below and see the ceremonial chamber? Just as he was about to descend, the darkness below sent a shaft of suspicion into his fearless heart, and he refused to go. Well for him was it that he let prudence control his acts at that time; for, in the darkness of the kiva a score or more of armed warriors were stealthily in waiting, watching for his steps upon the ladder, and, ere he had reached the bottom, a score of willing hands would have been dyed in his life blood, while armed men above would ruthlessly have murdered his little band of followers.

A few weeks later Oñate's maestro de campo, Juan de Zaldivar, who had been exploring eastward, came to Acoma with his thirty men, and, lured by the peaceful protestations of the Acomas, left fourteen of his men below to guard the horses, and then, with sixteen men, climbed the trail. With quiet stealth and under most friendly guise, Zaldivar and his men were scattered, when suddenly, like the whirling cyclone from the heavens above, all the warriors of the town fell upon the hapless Spaniards with flint knives, stone battle axes, heavy hammers, bows and arrows, and war clubs. Surprised, apart, unready, these adventurous warriors, who had braved the savages of thousands of miles of desert marches, one by one were slain. Here would be seen a desperate but hopeless conflict; a mailed warrior, back to wall, blood streaming through his broken helmet, surrounded by yelling, screeching, howling, naked savages, all attacking at once and with a ferocity altogether irresistible. Juan was slain, others of his officers and men, one by one, licked the barren rock in the agonies of death, and, at last, five soldiers only remained. Fortunately, they were able to get together, and thus, side by side, encouraging each other, they fought, striking and thrusting at every good opportunity into the dusky mass of surging savagery which determinedly forced itself upon them. Back, foot by foot, they were driven. Step by step they came nearer to the edge of those frightful cliffs. Yet death at the foot of a yawning precipice was preferable to captivity, torture, and horrible death at the hands of ruthless savages; so, cheering each other with brave words, these daring and desperate men flung themselves over the brink and commended their bodies and souls to Santiago, the patron saint of Spain. Courage and bravery were rewarded in all but one, who, falling on the solid rocks, was dashed to pieces. The other four, fortunately, breaking their fall on the soft, ever-changing sand heaps, escaped with their lives, and were soon in the helpful and soothing care of their comrades. The fear of their horses kept the camp below from the attacks they dreaded, and, just as soon as the wounded soldiers were able to travel, the little, sad-hearted band hastily set forth, some for the main army of Juan de Oñate, at San Gabriel de los Caballeros, the second city founded on United States territory, and others to give warning to the scattered Spaniards at Zuni, Moki and elsewhere to gather together at San Gabriel for mutual protection.

When Oñate heard the news, a determination for vengeance fired his soul. With seventy men he sent Zaldivar's brother, Vicente, to make his vengeful anger felt upon the Acomas. And would that I had space here to tell of that storming of the hitherto impregnable citadel. For three days and nights the battle raged. Deeds of daring and heroism were performed that well deserve to become famed. Step by step the ascent was made; blood was shed like water, scores of Indians lost their lives, and still the fight continued. But determined to avenge their comrades' treacherous murder, the soldiers of Vicente fought with a quiet, desperate valor that could know no defeat. There was but one alternative to victory, and that was death.

At last the rock itself was gained; then the town must be stormed. The one howitzer they had brought was put into use and the adobe walls blown down; fire aided the attacking forces, and at last the chief warriors sued for peace and offered to surrender. Dearly was Juan de Zaldivar slain, for it cost the Acomas the greater portion of their fighting men. In 1680 another uprising took place, when the Spaniards were entirely driven out of New Mexico and kept at bay for nearly eighteen years. Then Diego de Vargas, a daring Spanish cavalier, came as the reconqueror, and more scenes of battle and bloodshed were witnessed.

But now Acoma is quiet and peaceful. Last fall, and in the spring, and the falls and springs for years prior, I have walked in peace on these wind-swept rocky heights, looked down over the precipices where Zaldivar's soldiers leaped, and fearlessly climbed up and down the dizzy trails so furiously defended against the ascent of the avenging Vicente de Zaldivar. I have slept, unarmed and unwatched, without thought of danger, indoors and out of doors, where Acoma and Spaniard once fought in deathly conflict.

And far away in the silent night, often and again, have I gazed upon that equally impressive rocky mesa named by the Acomas Katzimo, and known by the white people as the "Mesa Encantada," or the "Enchanted Mesa." All are familiar with its story, viz., that it was once the home of the Acomas, and that a frightful storm and flood came which washed away all means of access to the summit. This the Acomas took as proof of the anger of those above; it was accursed, Katzimo, and henceforth must not be touched by the foot of man. Twelve years, or so, ago, the story was interestingly written, but writer and all visitors agreed that the mesa was inaccessible, so that none could tell whether the tradition was true or not.

Dr. William Libbey, of Princeton University, a well trained expert in scientific work, a geologist of lifelong training, a specialist in such work, who had spent weeks and months in the field for thirty years or more, determined to ascend the inaccessible height, and, providing for the maximum of difficulty, easily succeeded by means of line-throwing cannon and boatswain's chair in reaching the summit—the first white man in history to stand upon the sacred heights of Katzimo.

Later, Prof. F. W. Hodge, of the Bureau of Ethnology, of Washington, D. C., an equally well trained specialist in field work, made the ascent in much easier manner. Both gentlemen reported that no walls, foundations, or other ruins of dwellings were discoverable; only a few pieces of pottery, and other artifects of Indian manufacture were picked up, and the remnants of an old trail leading to the summit were discernible, yet both arrived at different conclusions. Dr. Libbey says this is not Katzimo, Prof. Hodge says it is.

To my mind the question to be decided is: Does anything on the summit or near the Mesa Encantada bear out the centuries-old tradition of the Acomas that this was once the home of their ancestors?

And this point, I think, it will be conceded, must be settled by one or more of the following:

1. By discovery of ruins on the Mesa large enough to account for the residence of a whole people.

2. By discovery of such evidences of occupation by large numbers of people as to reasonably satisfy the seeker, if the ruins mentioned in proposition one are absent.

3. By satisfactorily accounting for the absence of either ruins or direct evidences of occupation, if neither are found.

The importance of settling the discussion in a legitimate manner is evident to the student of Indian lore and tradition. It is readily apparent that, if this tradition is discredited, a first and great step is taken toward discrediting all Indian tradition, and thus another obstacle is placed in the way of arriving at reasonably accurate conclusions in regard to the prehistoric life of all Indian peoples. So, personally, I am profoundly anxious that the main and important features of the Katzimo tradition of Acoma should be preserved in all their integrity and fullness, and ultimately demonstrated, beyond all question, to be true.

That evidences of human presence were found on Katzimo all agree, but there is a vast difference between evidences of human presence and evidence that a large village or city was once here occupied.

Had the Acomas lived on the Mesa Encantada, several things are morally certain. These are:

1. They undoubtedly would have built their houses as elsewhere in this region we find mesa cities built, viz., not of adobe, which would have to be carried by arduous labor from the village beneath, but of the chips and pieces or blocks of sandstone left by erosion on the mesa top and on side terraces, easily accessible and far more suitable than adobe.

Ruins of such cities are found all through this region on mesas. On the mesa just above the Cibolleta ranch is a large circular fort ruin, with a circumference of nearly a thousand feet, built of sandstone, and in a fair state of preservation. About fifteen miles further west is another ruin on a mesa overlooking the lava fields. A wall 150 feet long (or more) crosses the mesa, and behind it is a large area covered with ruins. On the top parts of El Morro, or Inscription Rock, are also two stone ruins covering moderate sized areas. All these ruins are in a fair state of preservation, as the accompanying photographs show.

2. Had such a city existed on Mesa Encantada, the ruins undoubtedly would have remained exactly as in the cases referred to. I do not think large blocks and pieces of sandstone would have been eroded or washed away. The sloping condition of the Mesa Encantada summit is by no means unusual. The Circular Ruins at Cibolleta are on a sloping mesa, so also are the other two sets of ruins mentioned. And yet, according to the Indian traditions recounted to me both at Acoma and Zuni, and verified by Navajos, Mokis, and Lagunas, all these ruins are as ancient (or more so) as the ruins of Acoma would have been had they occupied Katzimo.

3. Another matter of importance should be considered. The village of the Acomas in the early days must necessarily have been much larger than the modern Acoma. For Juan de Oñate estimated its population at 3,000, and Villagra in his epic says it was 6,000 when the attack of Capt. Vicente de Zaldivar took place on January 22, 1599. Only 600 of these people remained after the conflict. The present day population of Acoma is less than 600, and yet six or more large blocks of three-storied houses are all occupied in housing them on their present site. Now, taking the population of 3,000 of Oñate's estimate—leaving Villagra's estimate out of the question—and then reducing the number to 2,000, or even 1,000, it is apparent that a large number of buildings would have been required to house them, even according to early Pueblo methods, and such a town would neither blow away nor wash away easily, or during many times many furious storms. That a half a score or more of such ruined cities still exist on wind, cloud, rain, and storm-swept mesa summits almost, if not equally, as exposed as the Mesa Encantada city (had it existed) would have been, nullifies, I would venture to suggest, that hypothesis.

Hence my own conclusions, viz.:

1. That while Mesa Encantada was undoubtedly the scene many times of human presence; and,

2. While the worn trail and other evidences clearly demonstrate that the Indians have often visited it, these facts ought not to be accepted as conclusive evidence of the truth of our interpretation of the Acoma tradition, viz., that their ancient city was once located here.

3. And that, in my opinion, both Indian and white man are at fault in regard to the exact location of Katzimo, and that further research will yet discover it and show far more positive and ocular demonstration of its having been the occupied site of a large city than the so-called Katzimo and Mesa Encantada of the present discussion has done. My reasons for advancing this last idea are:

1. My firm belief in the general truth and reliability of the tradition.

2. The unsatisfactory evidence adduced in favor of the village occupancy of the mesa hitherto known as the Mesa Encantada.

3. My knowledge of the possibility of error, both by Indian and white, owing to the lapse of centuries, in determining the location.

4. My actual conversations with Indians of Acoma, who definitely assert that the scaled mesa is not their Katzimo, and that "may be so" some day they will conduct me to the real, genuine, sole, and only Katzimo or Mesa Encantada, where many ruins are to be found.

PLANT HUNTING BY THE ANCIENT EGYPTIANS.

WE have historical proofs and actual records to show that in Egypt, at any rate, plant collecting abroad (i. e., in Arabia) took place thousands of years before the Christian era, says Amateur Gardening. Now let us glance at the actual evidence. On the walls of a room in the great Temple of Karnac at Thebes, there exist, perhaps, the earliest art records of plants existing in the world to-day. A series of exquisite carvings or sculptures adorn the walls, and these are representations of foreign plants collected and brought home by Thothmes III. on his triumphant return from a campaign in Arabia. These sculptured records show not only the natural aspect of plant or tree, but leaves and flowers; fruits or seed pods are shown separately, as in our modern botanical works of to-day. Mr. W. Flinders Petrie, the well-known Egyptian explorer and archæologist, has taken casts and photographs of these wonderful old records, and some of these may be seen in the museum at Cairo, in the British Museum, and elsewhere. These sculptured pictures, for some were colored originally, must not be confounded with the actual dried specimens of Egyptian garden and wild plants that have been found preserved in the mummy wrappings of Ahmes I., Rameses II., and other great men, and in the graves discovered at Dalschur, Sahkara, and Dier el Bahara. These actual flowers consisted of blue and white lotus, poppies, narcissus, grasses, palms, clover, barley, juniper, and other plants which grew and flourished at least 2,000 years before our Saviour was born at Bethlehem! Samples of these actual flowers as used in the funeral wreaths of Egypt 4,000 years ago may be seen in the museum at Cairo, as well as in the British Museum and at Kew.

But let us return for a moment to the stone pictures of Thothmes III., whose name can be spelt twenty or thirty different ways. In Rawlinson's "Ancient Egypt," p. 196, he says: "Thothmes noted all that was strange or unusual in the lands which he visited, and sought to introduce the various novelties into his own proper country. His artists had instructions to make careful studies of the objects and to represent them faithfully on his monuments. We see on these water lilies as high as trees, plants of a growth like cacti, all sorts of trees and shrubs, leaves, flowers, and fruits, including melons and pomegranates." Birds and beasts, also; herons and sparrowhawks, geese and doves are fairly mixed up together. Above all, however, let us read the inscription or legend Thothmes put up alongside his stone picture gallery: "Thus saith the King, I swear by the Sun, and I call to witness my Father Ammon, that all is plain truth, there is no trace of deception in that which I have done. What the splendid soil brings forth in the way of productions I have had portrayed in these pictures, with the intention of offering them to my Father Ammon as a memorial for all time."

Could anything be plainer put in our British Mu-

seum of to-day? Here we have actual literary and pictorial evidence, and in some few cases actual dried specimens, proving beyond a doubt that some, at least, of the Egyptian kings knew what they were about, and were pleased to find a "splendid soil," and collected, introduced, and figured its productions "as a memorial for all time." Apart though it be from my subject, I cannot help being just a little sorry that the great and memorable King Thothmes III. did not leave us as good a record of his native Egyptian plants, and especially of those growing in his "very own" garden, as he did of these "outlandish flowers" of other lands.

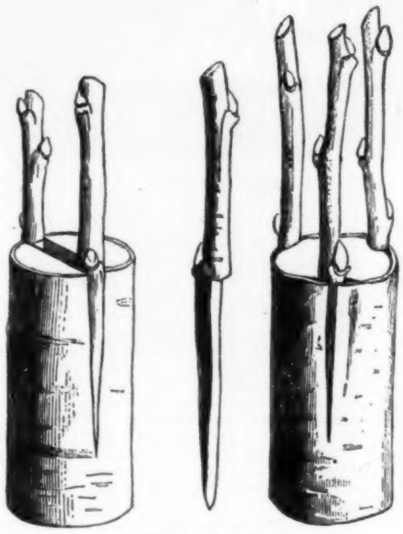
VARIOUS METHODS OF GRAFTING.

CROWN or Rind Grafting.—Where orchard trees of considerable size are to be worked with other varieties, rind grafting is the best method. Assuming that the crown has been reduced in size, cut the branches back to the desired length. If the tree has ten or twelve main branches, two grafts may be placed on each, and in a few years the tree will come into bearing—that is, if grafting is properly carried out; and it will possess a spread of branches equal to that the tree had originally. The stock may, if so desired, be headed hard back to one main stem, and three grafts be placed on this; but my experience with trees worked as the first named has been more satisfactory, and a full sized bearing tree is obtained in less time. The lower end of the scion in this method of grafting is for about 3 inches, cut sloping and slightly hollow, almost similar to the first process for whip grafting; and in the stock a downward slit is made in the bark to correspond in length to the sloped-off part of the scion. The handle of a budding knife or a smooth piece of wood shaped somewhat to resemble the part of the scion to be inserted is introduced at the top of the slit, and gently pushed down so as to raise the bark, and when it is removed the scion is pushed down in a similar manner. If a second one is to be inserted, this should be placed on the opposite side, and then both should be bound round with matting, and clayed over in the usual manner.

Cleft Grafting is often practiced in the West country. In doing it, prepare the stock as for crown grafting, and with a broad, sharp chisel split the head of the stock, leaving the instrument in, or using a wooden wedge to keep the split open, to allow of the edges being made smooth, and the scions inserted one on either side. Cut these wedge-shaped, and tapering to a point, making them quite thin by removing all the bark on the side that is placed toward the interior of the stock. Place the scions in position, and so that the inner bark corresponds with that of the stock; then remove the wedge, and bind securely with matting, and finish off with a good coating of clay.

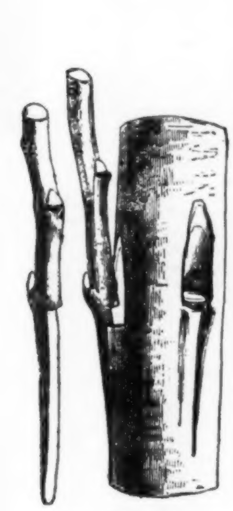
Saddle Grafting is not much in vogue, although a somewhat modified form is frequently used in the West, and formed the writer's first lesson in grafting. In this method the stock may be double the size of the scion, although uniformity in size is to be preferred. The latter is cleft for about 3 or 4 inches upward from the lower end, so that one side is thicker than the other. The rind of the stock is slit down and opened to receive the thicker side of the scion, the thinner being set astride the stock (the point of the latter should be cut off in a sloping direction) and down the other side, a small portion of the bark of the latter being removed corresponding in size to this end of the scion, which should fit closely and evenly to the stock. Afterward tie up securely with matting, and cover with clay. This kind of grafting may be practiced with success until quite late in the season.

Side or Bud Grafting.—This method, a modification of whip grafting, is useful for supplying buds to espalier, horizontal, or other trained trees, especially of apples or pears, where otherwise the loss of a shoot destroys the symmetry of the tree; and it is sometimes employed in the case of new varieties so as to hasten fruit bearing. A short slice is notched out of the stock at the spot desired to insert the scion, which in this case carries but one bud, and when inserted it should be exactly in the position it is wished the new shoot should start from, and the bud pointing in that direction. It should be carefully tied in with matting, and a little clay or grafting wax smeared over the parts.—The Gardeners' Chronicle.

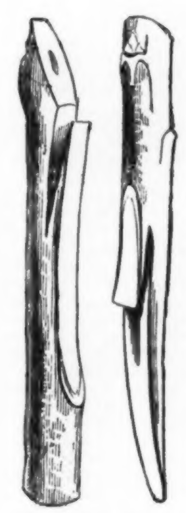


CROWN GRAFTING.

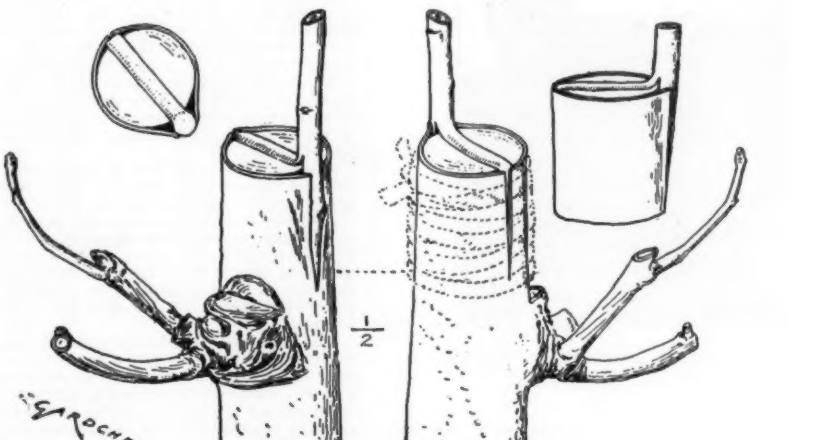
SADDLE GRAFTING.



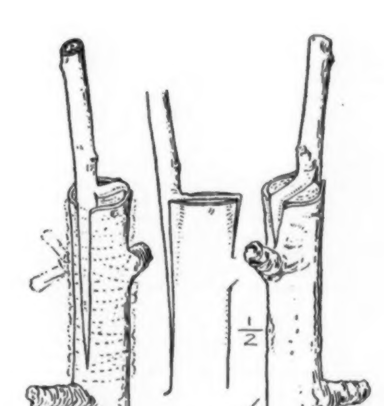
SIDE GRAFTING.



WHIP OR TONGUE GRAFTING.



Showing the graft in position before it is clayed or waxed.



Small branches grafted and ready for claying or waxing.

SMITH'S IMPROVED METHOD OF CROWN GRAFTING.

VARIOUS METHODS OF GRAFTING.

THE ANIMAL FEAR OF MAN.

IN a number of the English Spectator some account was given of the evidence collected by ancient and modern naturalists, from Don Felix d'Azara to Mr. Hudson, that the puma, the second largest of the big cats of South America, neither feared man nor regarded human beings as its prey, but on the contrary sought their society, and even protected man from the attacks of the jaguar. Trustworthy facts which lend additional confirmation to this interesting question must necessarily be slowly acquired. The following anecdote, which comes at first hand from one long resident in British Guiana, supports the belief that the puma seeks the society of man instead of attacking or fearing him. When making an expedition up one of the large rivers in a steam launch, our friend gave a passage to an elderly Cornish miner, who was anxious to reach the gold fields. Not wishing to intrude upon his hosts, he did not sleep on board the launch, but always slung his hammock between two trees on shore. As climbing into a high-slung hammock is not easy, he usually fastened it rather low, and his weight probably brought it to within three feet of the ground at the bottom of the curve. One morning, being asked how he had slept, he complained that "the frogs had made such a noise underneath his hammock that they had kept him awake." Some Indians of the crew who were folding up the hammock laughed a good deal when they heard this, and being asked the reason said, still laughing, "Oh, 'tiger' sleep with old man last night." They had found under the hammock the marks of where a puma had lain. The noise which had kept the occupier of the hammock awake was probably the purring of the puma, pleased at occupying the "next berth" below a man. As these Guiana Indians have, in addition to the unerring eye of the forest dweller, a special liking and capacity for taming animals, it can hardly be doubted that their conclusion was correct.

Such an absence of fear and liking for human society could only be paralleled by the behavior of some domestic cats. Yet in the case of the puma this can only be a survival of a primitive disposition, which has already been lost in a great measure by the same species in North America. Are we, then, to suppose that the absence of that fear of man so general among even the large carnivora was the rule in the primitive world? If it was, we shall have to account for the survival of man in the presence of creatures which did not fear him, and possessed a far more effective physical equipment for attack than man possessed for defense; for we cannot suppose that the benevolent neutrality which can safely be attributed to the puma was exhibited by the other carnivora. The evidence that fear is not the natural attitude of animals toward man is mainly of two kinds—the notes of explorers who have pushed into the few regions of earth where animals were numerous but man had not trodden; and the results of the very latest experiments of to-day in districts where the killing of animals has been absolutely prohibited. In other words, we must compare the behavior of the creatures in the Arctic seas in the days of Willoughby and Barents, or in the voyage of Weddell to the Antarctic, with the latest reports from Yellowstone Park. The results show a striking agreement in the demeanor of the beasts when first confronted with the new creature, man. Few of them exhibited fear, so far as the records show. When Barent's crew were on their first voyage, a Polar bear, who probably had never seen men before, took one of the crew, who was lying down, by the back of his neck, and, after dragging him some way, bit the top of his head off. Even now the Polar bear is the least shy of his race, though so constantly hunted.

The general tendency of wild animals kept in large reserves and never molested points to the same conclusion, though for obvious reasons none of the most dangerous carnivora can be maintained in such places. The fear of man is lost by creatures wild and free but unmolested, so quickly as to be matter of surprise to those most conversant with animals in captivity. Re-

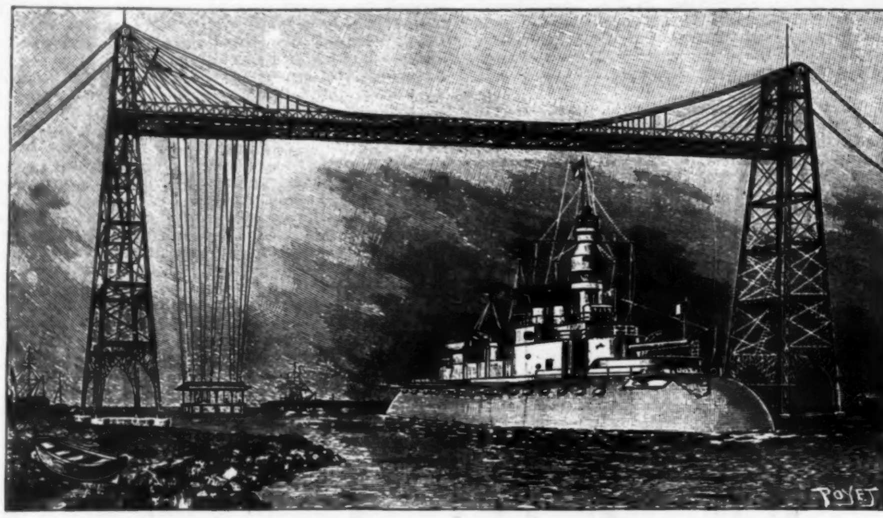
ports published in the United States newspapers dwell repeatedly on the loss of the fear of man by all animals in Yellowstone Park, where the deer (both wapiti and black-tailed deer) come to the houses to be fed, and even eat the flowers from the window boxes. Brown bears hang round the hotels and come daily to eat the refuse carted into the woods close by, and many of the smaller rodents are absolutely fearless. In menageries and zoological gardens the fear of man is lost mainly by constant and daily contact, with no power to escape, and by the remembrance that it is man who provides their food. But here the conditions are abnormal, and it would be useless to draw conclusions from the behavior toward man of animals in captivity and apply them to the solution of the earlier problem of the innate or acquired character of their fear of human beings. It is, however, matter of general knowledge that where man is weak and beasts strong and numerous, as in the country beyond the Zambesi and Shiré Rivers, the boldness of the animals leads to serious disasters. In the present day the only frequent reports of attacks of lions and leopards on men, for food, and not in self-defense or fright, come from these districts, though the story is as old as the rebuilding of Samaria.

If, as seems probable, the animal fear of man was acquired, and is not natural to their minds, it is not very clear how the very early tribes of men, when the larger carnivorous animals were far more numerous than now, escaped destruction and survived long enough to impress on the animal world the sense of fear by which man now dominates it. Regarded merely as a conflict between one class of animals and another, the result should not have been doubtful. Man ought to have disappeared from the face of the earth, or, in any case, to have retreated to remote strongholds in regions not frequented by the beasts. That he did not do so, but turned the tables on the better equipped offensive creature, is fair presumptive evidence that original man never was on a level with the animals in intelligence, but was equipped with the predominant brain power which has put him ahead in the race ever since. Primitive man, literally speaking, "lived by his wits," for he could have owed his survival to little else. He was not, for example, nearly so well equipped as the monkeys for physical defense or flight, though their survival is not altogether easy to explain on purely physical grounds. Their power of using their arms and hands as a means of swinging rapidly from branch to branch gives them an advantage over all the tree-climbing cats. Their habit of throwing missiles is also very disconcerting to other animals, though this art is only practiced by certain monkeys. But their rapid and intelligent combination for defense, menace, and look-out duty has contributed quite as much to their survival as their speed and activity. In tropical America even the monkeys are hard put to it to escape the attacks of such active and formidable foes as the harpy eagle and the ocelot. But it cannot be proved that even the most debased or physically weakest of mankind has ever been the "natural prey" of that "natural enemy" which, according to Sir Samuel Baker, is the nightmare of nearly every species of non-carnivorous animal. The causes which make exceptions to this rule are temporary and narrowly local. Even the Greenlander and the Esquimaux are the masters of the Polar bear, and probably always have been, though little better armed than primitive man, and the pygmies of the Central African forests are mighty hunters. It may even be that the neighborhood of fierce animals aided the early development of man; for the least developed races are largely found in such places as Tierra del Fuego, where, in the absence of savage beasts, savage man had no inducement to arm and equip himself.

But man has had an even more potent ally than his own ingenuity which from remote antiquity has invested him in the mind of the animal world with something of the supernatural. He is ever accompanied by the one element which the animal mind cannot create, cannot understand, stands in constant awe of, and dreads by night, when its courage is greatest, and that of man least steady. Fire, that pillar of cloud and flame which precedes, not the aggregate human host, but the smallest fragment of the invading army, the constant and dreaded harbinger of human presence, springing up, as the beasts must think, automatically from the earth wherever man rests his body, guarding him in sleeping and waking, always associated with his abode, has for ages terrified the beasts. Since the first appearance of man in any given region of the earth he has been teaching the beast to fear him; and it is not until to-day, when he is absolutely their master, and has, in many instances, totally destroyed them, that he thinks of restoring on a tiny scale, and on a few spots on the earth's surface, the "state of nature," and allowing those creatures, which he dares to experiment with, once more to lay aside their acquired terror, which makes them flee his presence.

THE SUSPENSION BRIDGE AT BISERTA.

ON the coast of Algiers lies the very old town of Biserta, the Hippo Zaritus of the Romans. For centuries it dragged out the miserable existence of a fishing harbor that was gradually filling up, and could never hope to attain importance of any kind. But since the year 1886 the strategical importance of this point has been better understood, and the French government decided to appropriate a certain sum of money to be used chiefly for the construction of piers that would protect the harbor from being entirely filled with sand. The result of this first work was so very favorable that work was begun in earnest with the object of making Biserta a first-class harbor for war and commercial purposes. To-day the harbor can accommodate the largest ocean steamers and war vessels; at least this is true of the outer harbor, that is, the roadstead which is protected by two piers. This is connected with the inner harbor by a canal which is 203 feet wide and through which ships with a draught of 24 feet 7 inches can pass. The inner harbor is a lake which has been dredged out. The change in the level of the sea at the ebb and flood tide causes a current which, although it does not interfere with the passage of ships through the canal, renders the crossing of the canal in boats very difficult. In order to overcome this difficulty, an ingenious suspension or hanging bridge has been built, similar to one which is already in operation in Spain between Portugaleta and Las Arenas, over the mouth of the Nervion. It consists essentially of an iron frame 148 feet high which is formed of two pillars, one on each bank, and connecting ironwork, which carries a platform that runs on rails and is run back and forth from shore to shore by an engine located on land with the help of wire cables. From this platform hangs the "bridge" proper, a sort of car, but without wheels,



THE SUSPENSION BRIDGE AT BISERTA.

which have been placed on the platform above. The bridge hangs so low that it touches the ground on both banks, and yet the frame is so high that even ships with very high masts can pass under it easily.—Für Alle Welt.

AN UNSINKABLE AND UNCAPSIZABLE BOAT.

NUMEROUS attempts have been made to construct unsinkable and uncapsizable boats, but, in spite of ex-

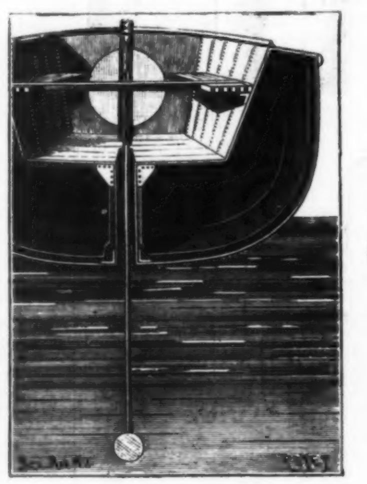


FIG. 2.—TRANSVERSE SECTION THROUGH LIFEBOAT.

tensive experimentation, no really practical and economic solution had been attained. M. Albert Henry has succeeded in solving the problem in a very simple and rational manner; and some official trials which recently took place at Rochelle demonstrated the forced righting of the hull and the immediate emptying of water entering it from any cause whatever.

The construction of this boat will be readily seen from Fig. 1 to be quite simple. In the interior of an ordinary hull is placed, so to speak, a second hull which forms the interior of the boat, and is perfectly tight. The closed space between the two hulls forms an air chamber which is divided into compartments by partitions. For the correct working of the boat, it is indispensable that the floor of the inner hull be above the level of the water. A longitudinal opening in the floor gives access to a well which opens at the exterior of the true hull, thus placing the interior of the boat in communication with the water in which the craft floats. The opening also permits of a movable centerboard to be placed in the boat. This is made of sheet iron weighted with a cigar-shaped piece of lead, which is fastened to its bottom, and suitably suspended, so that it can be raised when the boat is not in use and lowered when it is in motion. By means of this heavy centerboard the center of gravity of the boat is considerably lowered. The boat is rendered uncapsizable, therefore, by the combination of the air chambers and the centerboard of proper surface, which keep it always at its water line.

The boat is likewise rendered unsinkable by the air chambers and the longitudinal slot in the floor, above the water line; for any water which enters the boat must necessarily flow out by this opening, since the floor is above the level of the water outside.

In order to complete this rapid description of M. Henry's boat, it is only necessary to add that the design is applicable to almost any craft, from a lifeboat to a pleasure yacht; and the boat may be operated with oars or sails with the greatest security. Provisions may be stored in the air chambers, and in the large boats small beds even may be placed there.

The principle upon which M. Henry has constructed this boat is certainly very simple, and the remarkable results which have been obtained at the official trials at Pallice-la-Rochelle augur well for a very extended use of his craft.

A large lifeboat 40 feet in length, constructed by M. Decout-Lacour, was experimented with before some naval officers, representatives of the life saving service and of the steamship companies, members of the press, and a large crowd. The first time the boat was tipped till the centerboard was out of water, i. e., through an angle of about 90°. Left to itself, the boat quickly righted, and the large quantity of water it had shipped passed out through the well in the bottom in about one second.

The boat was completely uncapsizable, for, when left with the keel in the air (which position was obtained only by a great effort, thus proving that this contingency is hardly to be feared in actual service), the boat resumed an upright position instantly, and in four seconds time became completely empty.

The trial of the boat was terminated by an experiment calculated to show its endurance in a heavy sea. A large tank containing 1,760 gallons was placed on the quay of the basin of La Pellice at about 10 feet above the boat. The contents of the tank were dumped into the boat, which sank completely under the violence of the shock, but rose again quickly, all the water

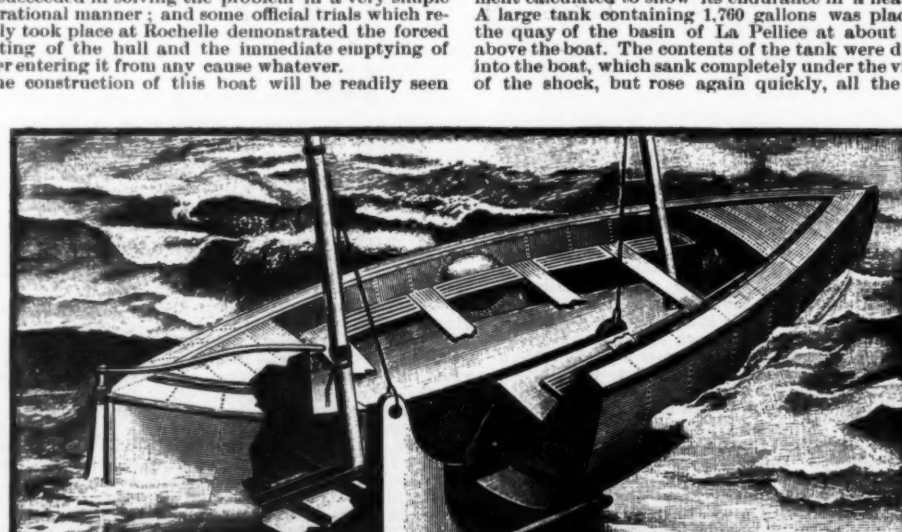


FIG. 1.—AN UNSINKABLE LIFEBOAT.

which filled it immediately flowing out. This last experiment seemed to prove conclusively that the boat was absolutely unsinkable and uncapsizable.—We are indebted to La Nature for the engravings and article.

ALLEN & BARKER'S GAS AND OIL ENGINES.

MESSRS. Allen & Barker, of Taunton, make a series of gas and oil engines varying from one to thirty brake horse power. In these engines are to be found several features which are the invention of the members of the firm, and which are worthy of note. Some of them are illustrated herewith. Fig. 1 shows the cylinder of an oil engine which has an impulse every other revolution, whether the engine be exerting its full power or not, and which is fitted with a vaporizer (Figs. 2 to 6) that is stated to run for long periods without needing cleaning. This vaporizer is heated by the same lamp which keeps the igniting tube incandescent, and gets a supplementary supply of heat from the exhaust gases. The oil to be vaporized is sucked into the passage, *a* (Figs. 4 to 6), by the outstroke of the piston and enters the tubes, *h*, and the annular space, *f*, where it is converted into vapor. It finally is drawn away to the cylinder through the tube, *g*, and the branch, *e*. To regulate the supply of oil a small regulator valve is fitted at *a*. By opening this valve more or less air can be admitted and the suction on the oil can be adjusted, and hence the richness of the mixture. The annular space, *f*, is inclosed between two walls, each of which is heated. The inner wall is heated by the gases from the lamp, which pass right through the central aperture, as through a chimney (Fig. 3), while the outer wall is heated by the exhaust gases. These enter at *b*, circulate in the space, *c*, and are finally emitted at *d* (Fig. 4). The volatilization of the oil is thus effected entirely by heat which would otherwise be wasted, while the narrowness of the space in which this is effected secures a very active movement of oil and vapor through it.

The engine illustrated is fitted with a valve, serving the purpose of a "timing valve," to control the supply of explosive mixture, or gas, to the ignition tube, as shown in Figs. 7 to 9. The casing of the valve has an opening, *j*, into which the ignition tube is fitted. With in the casing is a hollow plunger, provided with a hole, *k*, which, immediately before the explosion, comes opposite the hole, *j*, and allows explosive mixture to flow up the casing and valve, and enter the ignition tube. Normally the plunger is kept at the top of its stroke by a spring coiled around its spindle, *l*, a part of which is squared to prevent rotation of the plunger. A cam on the side shaft depresses the piston, and causes the ignition to take place at the correct moment, thus preventing back-firing. In more recent engines this device has been dispensed with, as it was found to be unnecessary.

The supply of vapor or gas to the cylinder is not, in these engines, uniform at each charging stroke, but is varied according to the load at each moment, the object being to obtain a more uniform turning effort than is got when some of the explosions are omitted, and the engine is carried at times through eight or twelve strokes by the inertia of the flywheel alone. To this end the inlet valve, *o* (Figs. 10 and 11), has a spring, *q*, around its spindle. The amount of compression of this spring, and consequently the distance the valve, *o*, will open under the suction of the piston on the charging stroke, depends on the position of the arm, *p*. As shown, the arm is in its lowest position, and the largest possible charge will be admitted to the cylinder, the air entering at *m* and the vaporized oil at *n*, the two mixing in the body of the valve casing before passing the valve, *o*. The arm, *p*, is connected to the governor, and when the speed of the engine tends to rise above the normal, the arm, *p*, rises, compressing the spring, and reducing the travel of the valve, *o*. By this means the amount of combustible mixture which can enter the cylinder is reduced.

It is stated, with every show of reason, that very steady running for electric lighting and such like purposes is obtained by this arrangement. The richness of the combustible mixture is kept constant, while its amount, and consequently the compression, is varied as the load changes. By removing the vaporizer and replacing it with an ordinary gas regulator, the oil engine becomes a gas engine.

It is well known that the ignition tube of a gas or oil engine is full of residual gas at the end of the exhaust stroke, and that its pressure often renders it difficult to get certain ignition. To prevent this Messrs. Allen & Barker sometimes employ a scavenging chamber, such as that shown in Fig. 12, to insure the removal of the burnt gases. The scavenging chamber is attached to the combustion chamber by the flange, *r*, while the ignition tube is fitted at *s*. When the exhaust stroke takes place, the part of the charge in the scavenging chamber expands suddenly and aids the evacuation of the contents of the ignition tube.

Figs. 13 and 14 show a coil of pipe, *t*, which is immersed in the oil tank; at *u* it is joined to the pump, while *v* is a foot valve. By this device it is intended to keep the suction pipe more or less charged with oil.

We are indebted to Engineering for the engravings and article.

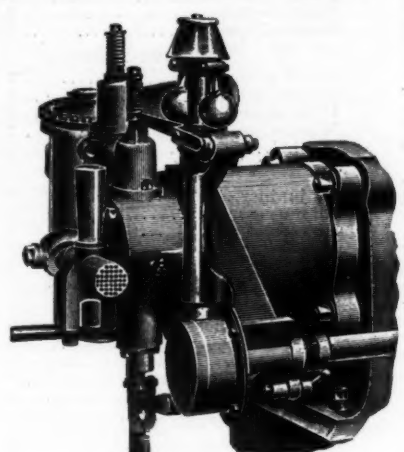


FIG. 1.

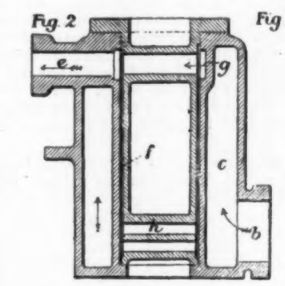


Fig 2

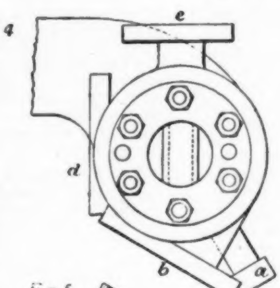


Fig 4

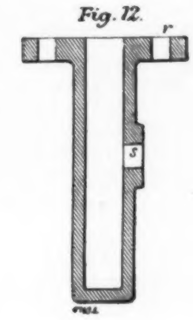


Fig. 12.

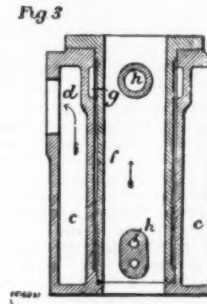


Fig 3

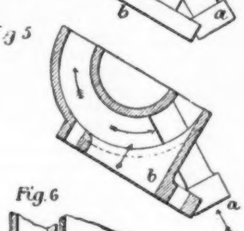


Fig 5

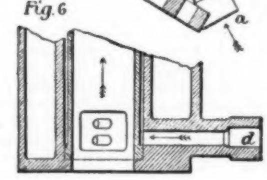


Fig. 6

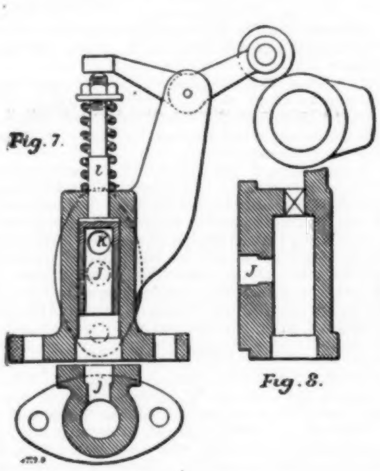


Fig. 7. Fig. 8.

Fig. 9.

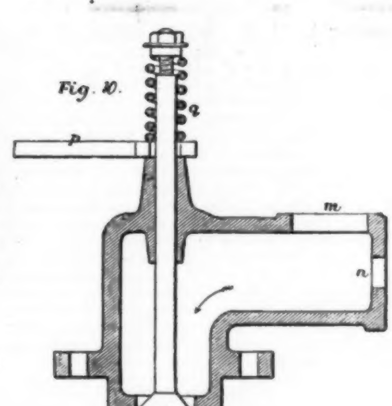


Fig. 10.

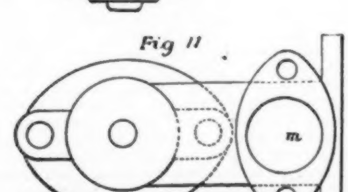


Fig 11

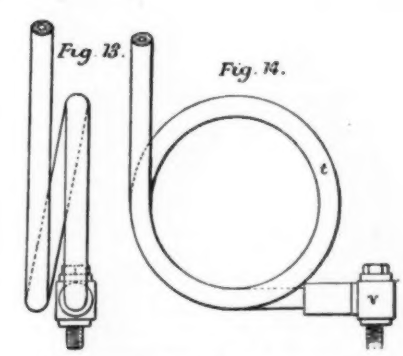


Fig. 13. Fig. 14.

OIL ENGINE.

DREDGE FOR RUSSIAN CANALS.

AT Seraing, a city of about 35,000 inhabitants, on the Meuse River, five miles above Liege, are located the extensive works of the Société John Cockerill, founded by John Cockerill, of England, in the year 1825. During 1898 there were employed in these works 9,849 workmen, and the engines in use had an indicated horse power of 23,000. The company has a capital of $13,-000,000, and is one of the largest of the kind in Europe. The greater portion of the coal consumed in the works is mined on the premises from three separate mines, which produced during 1898 more than 260,000 tons. During 1898 the works consumed 300,000 tons of iron ore, which in the main came from Bilbao, Spain, and 220,000 tons of pig iron.

Among the most important productions of this company for 1898 was one of the two immense dredges that are being constructed for the Russian government at a total cost of 2,900,000 francs ($559,700). The one just completed is called the "Volga," since it is to be used by the Russian government in digging the extensive ship canal to connect the Baltic Sea with the Volga River, which is one of the greatest engineering projects now under consideration on the Continent, involving the deepening and widening of the Volga its entire length.

The dredge is constructed on the principle of the dredge "Beta," in use in the Mississippi, but is very much larger, being able to remove 4,000 cubic yards of sand, gravel, clay, or similar material per hour to a distance of 700 feet. The earth is cut up and mixed with water by revolving trepans, until it is of a consistency that can readily be forced up by two powerful steam pumps of 1,428 horse power each.

The dredge has an electrical plant, to provide light and to run several small motors for the more delicate parts of the machinery.

The dredge is 214 feet 6 inches long, 61 feet 6 inches wide, and when ready for work, draws 4 feet 6 inches of water. It can excavate a channel nearly 80 feet wide and 14 feet deep at one cutting. The fuel used is naphtha, and when the dredge is in full blast, it consumes about 1,200 gallons per hour. Tanks are provided that hold sufficient fuel to run the dredge at full pressure for twenty-four hours. When in full operation, it will give employment to 36 men, as follows: Stewards, 6; engineers, 12; and laborers, 18.

The dredge will be given a trial on the River Scheldt, near Antwerp, Belgium, beginning about March 1, 1899. From there it will be towed to the vicinity of St. Petersburg, where it will begin its work.

ALFRED A. WINSLOW, Consul.

Liege, February 9, 1899.

MUSCLE AND MEAT.

THE six days' bicycle contest of a few months ago demonstrated that some men may undergo severe physical and a certain amount of mental strain without sustaining any appreciable immediate ill effects. One contestant declared at the finish that he was prepared to start on another journey on the following day, and physical examination, it is said, failed to find any reason to the contrary. The victor, after his 2,000-mile ride, was found to be in comparatively good condition, and it is a matter of interest that during the week he partook of no meat, but lived entirely on liquids, cereals, fruits, and eggs. Prof. Atwater, of Wesleyan College, made a study, to be incorporated in a report he intends soon to make, of the foods consumed in their relation to energy expended during the contest. According to the notes of his trainer, the following food was taken by the champion: Three pounds of rice, one pound of barley, four pounds of Scotch oats, four dozen pint bottles of prepared milk, one pound rice pudding with raisins, four one-pound bottles of beef extract, six raw eggs (in milk and lime water), ten quarts of milk, one half gallon of lime water, three pounds of grapes (on Saturday only), three dozen apples, one dozen oranges, one-half gallon of coffee. No stimulants were taken, and the total sleep during the race was nine and one-quarter hours.—Medical Record.

ENGINEERING NOTES.

Last year the Baldwin Locomotive Works completed 760 locomotives. Much of the output was shipped to foreign countries, the larger part going to Japan and Russia. This record does not, however, reach that of 1891, when 946 engines were built.

A train is now running between Chicago and Denver, a distance of 1,024 miles, covering the distance in 25 hours 15 minutes, equivalent to an average speed of about 40 miles an hour. This remarkable run is made on the Burlington line and is the result of competition with the Rock Island line.

A tube manufacturing company of Philadelphia is making seamless tubes of an aluminum alloy having a thickness of No. 36 gage or more, and drawing them over steel tubes with the aid of special machinery. The finished product is said to cost very little more than galvanized iron tubing, and combines the strength of steel with the advantages of aluminum.

At the Wishaw Works of the Glasgow Iron and Steel Company over sixty-eight tons of steel were tapped from one of the four large melting furnaces a short time ago. This is believed to be the largest charge hitherto worked in one open-hearth furnace. It is, however, proposed at Wishaw, as soon as arrangements can be made for that purpose, to melt an average charge of sixty tons in each of the four large furnaces.

Serious damage was recently inflicted upon rails on the Wabash Railway by hauling a disconnected engine at a speed of about forty miles per hour. Ten rails are said to have been broken and 772 were so badly surface-bent as to require their removal. The rail weighed 63 pounds per yard, and the driving wheels of the engine were 56 inches in diameter. The road has a rule limiting the speed of disconnected engines to twenty miles per hour.

The Age of Steel is authority for this statement of the remarkable life of a leather belt. This belt, of double thickness and 24 inches wide, has recently been laid on the shelf and is not as much the worse for wear as might be expected. A few worn spots were the occasion of its removal. The belt, which came from Boston with the main engine, was placed in service in the State penitentiary at Huntsville, Tex., in 1857, and has been in continuous service until its removal in November, 1898.

At the half yearly meeting of the Midland Railway, recently held at Derby, Sir Ernest Paget, president, referred to the action of the directors in ordering engines from America, and said this had been absolutely necessary to enable them to carry on their business. The English firms could not guarantee delivery for fifteen months at the earliest, but the Americans would deliver them in four months, and the directors had consequently doubled the order. He was afraid that the difficulty of coping with the orders in the engineering trade was partly due to the engineers' strike.

The action of carbonic acid in water on iron pipes is shown in two cases in Stahl und Eisen. The first case was in one and one-fourth miles of iron pipe laid near Beuthen, Silesia, connecting a pumping station and a reservoir. After two years' use the pipe began to leak, and it was found to be deeply pitted and punctured along the upper third of the pipe, the rest of the pipe being intact. The cast iron in the pipe was of average quality. The second case was at Johann-on-the-Saar, where the water, which is soft and very pure, came from the carboniferous deposits of the Saarbruck district. After some time the water passing through this pipe became a dirty brown and unfit for use, though the source remained unchanged. An examination showed that these waters were saturated with carbolic acid, or 126 cubic centimeters CO_2 per liter, either free or as bicarbonate. Attempts to remove it by aeration failed, and atomizers are now being tried.

In some recent experiments on the comparative friction of roller bearings, it was found that in a trial of two trucks loaded with 3,300 kilogrammes (7,260 pounds) each, one having ordinary boxes and the other roller or ball bearings, the following differences appeared: In the truck with ball bearings the resistance per ton was 2·74 kilogrammes, while in the other it was 8·10 kilogrammes, or in the ratio of 1 to 2·9. The trucks were then loaded with five tons each to make the total weight 8,300 kilogrammes. The resistance was found to be for the first 2·51 kilogrammes and for the second 8·74 kilogrammes per ton, or in the ratio of 1 to 3·67. On increasing the load to ten tons, the resistance increased to 2·62 kilogrammes per ton and 10·23 kilogrammes per ton, the ratio of which is 1 to 3·9. The experiments were made by allowing the cars to roll down an inclined plane and carefully noting the distance passed over before they came to rest and the difference of level of the two points, from which were calculated the resistance per ton and the effort of propulsion.—Railroad Gazette.

The Falk system of rail welding, introduced in the United States in 1894, has already found application in several European states. In France, Lyons tried the system first; Paris, Marseilles, Le Havre, Rouen, followed last year. The process is sufficiently known, but an illustrated article by Magnier in the Revue Technique is none the less interesting. The rail ends have first to be cleaned; this is generally done by means of metallic brushes and coke, or with the help of hydrochloric acid. Barrotte tried sandblasts in Paris, but the device was too expensive. A mould consisting of several parts is fixed about the joint, a bar keeping the rails in good alignment. Iron is then cast into the mould. The car which carries the crucible is fitted with a Field boiler, a Laval turbine, a Rateau blower, etc. To make sixty or seventy joints a day required at Marseilles eighteen men, and, further, a driver and a guard. There is no real weld. The demarkation line between the rail and the iron can always be seen. The joint holds, because the cooling metal contracts. Broken joints seem to be due to blisters and to sudden cooling; thus the rain did some damage at Marseilles, falling on some still red joints. In Paris locomotives weighing up to eighteen tons were run over joints three hours after their being cast. The electric resistance is greater than that of the rail itself, but not much. Trouble from the expansion of the rails in the heat of the summer need not be feared. But the cast joints are awkward in case of repairs of the track.

MISCELLANEOUS NOTES.

Germany exports more books and other publications to Russia than to the United States. The figures for 1898 are 1,228 tons and 1,000 tons respectively. Switzerland imported 1,623 tons of publications from Germany in 1898, and Austria-Hungary, 5,497 tons.—Uhland's Wochenschrift.

The record of fires in the boroughs of Manhattan and the Bronx for a month has been broken again. During the month of February there were 612 alarms of fire. The greatest previous numbers were received during the preceding month, when 564 alarms made a new record. February had three less days and accomplished it.

It is reported from Vladivostok that gold has been discovered along the Ussuri River, and that a movement is on foot to induce the leading merchants of Vladivostok to combine for the purpose of undertaking the immediate working of the deposits. At the same time it is reported from St. Petersburg that immense beds of coal of an excellent quality have been found in the vicinity of Chabarovsk.

An interesting exposition was given by MM. Résal and Alby, the engineers of the Alexandre III. bridge, a short time ago to the Société des Ingenieurs Civils de France, and took place on the bridge itself, where the engineers explained the system of the construction and erection of the bridge. At the present time eight of the steel arches have been put into place, and M. Résal declares that the mounting will be terminated by May next. The sculptors are now at work on the decoration of the stone entrances to the bridge, and very shortly it will be possible to judge of the effect of the whole work.

There are many strange places of worship, but one of the most remarkable is doubtless the miners' chapel in Mynydd Menydd Colliery, Swansea, Wales, where for more than fifty years the workers have each morning assembled for worship. This sanctuary is situated close to the bottom of the shaft. The only light is that obtained from a solitary Davy safety lamp hung over the pulpit from the ceiling, and the oldest miner in the colliery is generally chosen to officiate. It is the custom in some other places for coal miners to gather at meal times for prayer meetings and the like, but it is said that this is the only instance where a special apartment is fitted out in a coal mine as a chapel.

A steel roadway, about 150 feet long, is being laid at the Minnesota Agricultural Experiment Station. The steel rails are 8 inches wide, with half-inch flanges at the outer edge, and are 30 feet long. They are made of quarter-inch steel, with cross ties every 6 feet buried about a foot. On the ties are timber springs on which the rails lie. The width of the 8-inch rails takes in wagons of any width of tires. This demonstration of the steel roadway is being made in order to try to show its advantages over the ordinary macadamized road. It is asserted that such a road costs $2,500 a mile, while a macadamized road costs from $3,000 to $6,000, and that the steel road will outlast the macadamized and be far more serviceable.

"**According** to M. I. Holl Schooling, of Brussels," says Cosmos, "there is an old rule for finding the length of a man's life if the present age lies between 12 and 86 years. This is the rule: Subtract the present age from 86, and divide the remainder by 2; the result will give the number of years you have yet to live. This old rule was discovered by the mathematician DeMoivre, who emigrated to England from France in 1865 and became a member of the Royal Society. The curves given by M. Schooling are interesting to examine. A first diagram shows the chance that every man has of living one year longer than his present age. At birth, this chance is 5 to 1; at 5 years, 119 to 1; at 10, 512 to 1; at 15, 347; at 20, 207; at 25, 156; at 30, 120; at 35, 97; at 40, 78, etc. M. Schooling affirms from his calculations that of 1,000 individuals of 60 years, 599 will live to be 70, 120 to 80 years, and 17 to be 90; while of 1,000 nonagenarians, 4 will reach their hundredth year. We may add that for men of 65, the average expectation of life is 10½ years."

Rohrbeck and Oehmke have devised a new type of Bunsen burner, which is hardly more complicated than the old burner, and seems to offer certain advantages—certain disadvantages, too, we think. The burner has the well known shape. Round the lower part we observe a hollow ring, from which the connecting pipe starts. This ring chamber communicates with the interior of the tube through a number of oblique upward perforations. The tube is open below. We, therefore, get a kind of rising, hollow gas cylinder, the interior of which is filled with air. We have a better mixture of gas and air than in the common Bunsen, and we quite believe that such burners give intensely hot flames also for oil, petroleum, benzene lamps, etc. It is further pointed out that the flame cannot strike back, and that the liquid in the china dish over the burner may boil over without clogging the gas jet so badly. That is all satisfactory. But the adjustment is to be made by means of a disk, fitted into the tube from below. This suggestion does not sound practical. However, the burners are in the market.

The constancy of composition of natural gas is a question of some practical importance to manufacturers in the Pittsburg region, and as the opinion has been frequently expressed that natural gas fluctuates in its heating power, it seemed worth while to see if these changes in composition really occur. The results of an investigation by Mr. F. C. Phillips on this subject are given in the Proceedings of the American Academy of Arts and Sciences for November, 1898. Since the nitrogen in the gas appeared to be the most readily determined constituent, attention was first directed to this element, and an apparatus devised by which comparatively large quantities of the gas could be completely burned by red-hot copper oxide, and the residual nitrogen collected and measured. The results of duplicate determinations on the same sample of gas were closely concordant, the variations not exceeding in any case 0·03 per cent.; but since samples of gas from the same well, collected at different times, showed variations of nearly 2 per cent., it would appear that fluctuations in the composition of natural gas do really occur.

SELECTED FORMULÆ.

To Remove Stains from Half Tones.—To remove stains from copper half tones some operators use acetic acid and salt, the salt being dissolved in the acid. The half tone can be brushed with this without disturbing the enamel.—Inland Printer.

Artificial Wine Essences.—The following have been published as suitable for flavoring purposes:

ESSENCE OF SHERRY.

Oenanthic ether	1	ounce.
Nitrous ether	2	"
Rectified spirit to	1	pint.

ESSENCE OF PORT.

Acetic ether	1	ounce.
Essence of grape	4	"
Essence of vanilla	4	"
Tincture of kino	4	"
Essence raspberry	8	"

ESSENCE OF PORT.

Butyric ether	2	ounces.
Acetic ether	1	"
Amyl acetate	1½	drachms.
Essence vanilia	1½	ounces.
Tincture orris	2	"
Rectified spirit to	1	pint.

BRANDY ESSENCE.

Oil of prunes	2	ounces.
Butyric ether	1	drachm.
Oil of cognac	4	"
Wine ether	1	ounce.
Alcohol	4	"

ESSENCE OF GIN.

Oil juniper	1	ounce.
Oil nutmeg	1	drachm.
Oil caraway	6	minims.
Fusel oil	10	"
Rectified spirit	16	ounces.

MADEIRA WINE ESSENCE.

Nitrous ether	1	ounce.
Oenanthic ether	4	"
Cocinic ether	2	"
Wine ether	1	"
Tincture vanilla	4	"
Rectified spirit to	1	pint.

CLARET WINE ESSENCE.

Oenanthic ether	4	ounces.
Nitrous ether	1	"
Acetic ether	5	"
Wine ether	2	"
Rectified spirit	4	"

—Pharmaceutical Era.

Lacquer for Tin Plate.—The following formulas have been recommended for giving a lacquer finish to tin plate:

1.—Clean the tin plate carefully and apply the following mixture with a brush: Dark copal lacquer, 3 parts; linseed oil, 1½ parts. Dry the plates. The lacquer will not crack or lose its luster if the tin plates are bent or hammered.

2.—Alcohol, 1 quart; shellac, 4 ounces; red saunders, 1 ounce; turmeric, 2 ounces. Shake frequently for twenty-four hours, and bottle. Various colors can be given to the lacquer by adding Prussian blue, lakes, etc.

3.—Red: Put 3 ounces of seed lac and 2 drachms aniline, color of shade to suit, into 1 pint well rectified spirits. Let the whole remain for 14 days, but during that time agitate the bottle once a day at least. When properly combined, strain the liquid through muslin.

Brannt gives the following formulas under

JAPAN FLOW FOR TIN.

1.—Spirits of turpentine, 3 quarts; tolu balsam, 3 ounces; linseed oil, ¾ pint; acetate of lead, 3 ounces; balsam of fir, 3 ounces; sandarac, 1½ pounds.

Put the materials, except the turpentine, in a suitable vessel, place first over a slow fire, then increase the heat until all is melted. When a little cool, stir in the turpentine and strain. The japan is transparent, but may be colored if desired.

2.—Melt 5 pounds Naples asphaltum, 12 ounces dark animé. Boil for about 2 hours in 1 1-5 gallons linseed oil; then melt 1 1-5 pounds dark amber and boil it with 1-5 gallon linseed oil; add this to the other and add driers. Boil for about two hours, or until the mass, when cooled, may be rolled into little pellets. Withdraw the heat and thin down with 3 gallons of turpentine. The mass must be continually stirred to prevent boiling over.—Pharmaceutical Era.

Hardening Steel.—A new process of hardening steel is to coat the metal with a mixture of whiting and varnish, heat to a cherry red, and to then dip for a few seconds in acidulated water. The steel is then dipped in rape oil for a slightly longer time, and is finally laid in a cooling bath of rock oil or a mixture of water and whiting. By dipping the steel first in the water, the heat is drawn away from the outer layer, which thus becomes hard. Dipping it in the rape oil retards the cooling of the interior of the metal, and obviates the risk of cracks appearing.—Practical Engineer.

To Bleach Green Leaves.—The following is the best plan that we have ever tried: Put into a flat dish or platter a pint of rain or distilled water, and add an ounce of calcium chloride well broken up. Add sufficient acetic acid to liberate the chlorine, and then lay the leaves in the water so that they will not cover each other. Put a cover over the dish so as to retain the liberated gas as much as possible. In ten minutes remove the cover and examine the leaves. The thinner and more delicate will be found quite white and bleached, as a usual thing. Remove these by slipping a piece of stiff paper, or a card, under the leaf, lifting carefully, and float in a basin of fresh, clear water. When the rest of the leaves become white, remove them in like manner to clear water, and after rinsing the surface either by gently pouring on more water or by lifting with the paper and turning over, drain off the water and very gently pour in a fresh supply. Let the leaves remain in this until the chlorine odor vanishes, then remove (using the paper lifter), and put on a blotting pad to dry.—National Druggist.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Sulphate of Copper in France.—Under date of March 15, 1899, Consul Skinner, of Marseilles, says: There is at present a considerable advance in the market price of sulphate of copper, which is quoted in this city at 64 francs ($12.35) per 100 kilogrammes (220 pounds). The price named is about 5 francs (96 cents) above the ordinary price for the quantity named. Large quantities of sulphate of copper are used in the wine-growing districts to counteract the pernicious effects resulting from the various cryptogamic diseases to which the vines are subject. During the year 1898 there was exported from the United States sulphate of copper to the extent of 14,529,466 pounds, valued at $466,244. On these terms, it would seem as though a considerable business might be done in France, especially under existing market conditions. I venture to add a number of addresses of dealers in this line for the benefit of those whom it may concern: Emery, rue des Trois Mages 2; Schloesing Frères et Cie., rue Armeny 1; P. Millaud Fils, rue Haxo 20.

American Bolts and Nuts in Scotland.—Inquiry has been made at this consulate, says United States Consul Rufus Fleming, of Edinburgh, by a wholesale agent, handling largely bolts and nuts and like articles, for the name and address of a company or firm in the United States manufacturing bolts (round and square, countersunk heads) and cold-cut nuts. He wishes to obtain this particular combination for the Scottish market.

This business man informs me that the American manufacturers are now pushing the Germans very hard for the trade in bolts and nuts in the United Kingdom. The importation of these articles from the United States began about eighteen months ago. For many years the German manufacturers had little or no foreign competition in these islands for machine-made bolts and nuts, and the British manufacturers could only hold the market for the common square-head bolts. In 1897 bolts and nuts began to come from the United States, and the trade has been growing. Of late it has been increasing rapidly. In this dealer's opinion, should there be no reduction of prices by the German and no increase of prices by the American manufacturers, the latter will soon get the bulk of the trade. The process of gaining the market would be easier, he says, if some of the American bolt and nut manufacturers did not persist in sending the goods in packages of fifty and of one hundred, although they know that it is the custom in the retail trade here to buy bolts and nuts by the gross and half gross.

Trade Conditions in Jamaica.—In reply to inquiries by the editor of a New York trade journal (to whom the original letter has been forwarded), Consul Dent, of Kingston, under date of March 6, 1899, writes:

Practically all of the purchases here are on credit. Some few merchants discount their American bills for cash at two per cent. The usual English discount for cash is two and one-half per cent., and at least one house here has received that discount in the United States. The usual credit is three months, but merchants desire that the credit be three months here or four months in the United States, in order to allow shipment of goods and return of payments.

Invoices are usually settled by acceptances of drafts drawn though the Colonial Bank or the Bank of Nova Scotia. The rate of interest is six per cent. There is no way by which information can well be obtained as to solvency of merchants, except through the banks. The information, I think, would hardly be given by letter, but might be obtained through the New York correspondent. The Colonial Bank has an agency in New York, and the Nova Scotia Bank's correspondent is the Bank of New York.

The collection of accounts can be readily made here, when the sum is under £50, in the petty courts. Above that sum the litigation would be extremely expensive. It is not at all desirable to engage in litigation here. Collections can be made through the banks, as the failure to pay an account so presented involves loss of credit. Bank commissions for collection are from one-half of one to one per cent. Debtors are allowed no exemptions whatever. Exchange charges are high, both in selling and buying drafts.

The Lofoden Fisheries.—There is a very large traffic carried on with the Lofoden Islands during the fishing season, says Victor E. Nelson, of Bergen, and it is estimated that often between 35,000 and 40,000 men are engaged, and during the busiest time, which is toward the end of March, as many as 7,000 vessels of various kinds are in these waters. Of course, it requires a large number of hooks, nets, etc., to supply these men with the necessary gear for catching fish, and heavy losses are often sustained. It is estimated that the annual loss in the various kinds of gear employed in these fisheries alone amounts to from $175,000 to $250,000. Needless to say, this loss has to be replaced by new material, and it has occurred to me that United States manufacturers might supply this annual deficiency. Of course, some sacrifice would have to be made before trade could be established, as the people here are conservative; but, by judicious management, American goods of all kinds could gain a sure foothold in Scandinavia.

When steamships were first used in the Lofoden fishing trade they met with violent opposition, the fishermen looking on them with distrust; to-day nearly nine-tenths of the trade with the Lofoden Islands and the north of Norway is carried on by steamers.

There are generally seven doctors appointed every year to look after the men engaged in this trade, and, in addition to these, there are some four or five in the other fishing districts. These physicians attend about 8,000 or 9,000 patients every year, and there are often between 500 to 600 in the hospitals. Medical attendance is supplied to these fishermen free of charge, the doctors being paid out of the medical fund, which is kept up by levying a tax on all fish and fish products exported.

There are several clergymen stationed permanently in different parts of this district, and four state chaplains are in attendance during the fishing season. Five libraries have been established, as well as four night schools, and during the last few years, many fishermen's homes have been opened in different places. As a rule the people are orderly and sober.

There are twenty telegraph stations in operation in the Lofoden district, and during the last four months of the year 1897 over 96,000 telegrams were sent and received. The cost to the government to keep up these and other offices is about $10,000 to $12,000 a year.

Several life-saving sailing vessels and a fine steamer are stationed in various parts of this district. In the year 1897 there were 35 wrecks, 18 men drowned, and 139 men saved. In 1896 there were 25 wrecks and 22 men drowned, and 81 saved.

There is an insurance company in the Lofoden Islands, and upon the payment of about 25 cents a year a fisherman can have his life insured for $53 or $54 (200 kroner).

The estimated number of fish caught every year is 15,000,000 to 18,000,000 cod and 25,000,000 medium sized fish, the value of which, when bought from the fishermen, is $1,500,000 to $2,000,000.

Trade Conditions in Western Mexico.—In a letter to the editor of a New York trade journal (to whom the original has been sent), Consul Kaiser, of Mazatlan, under date of March 6, 1899, says:

Nowhere is there a more profitable field for practical missionary work, which would benefit both the buyer and the seller, than this part of Mexico, which seems almost wholly forgotten by our usually active merchants.

Mazatlan is a city of 16,000 inhabitants, steadily progressing, and with prospects of being one of the first commercial centers in Mexico. All business houses here are busy, and their trade is steadily increasing. Last year's sales of merchandise, according to the sworn statement at the collector's office, amounted to over $40,000,000, and doubtless, this year will show an increase of nearly $10,000,000. There has not been a failure or a fire here for almost fifteen years, and losses on account of bad debts amount to very little. There are three banks, and three of the largest merchants have a banking department connected with their stores.

Mexico is rapidly developing mines and extending railroads. Concessions have been granted to local capitalists to build two lines to Mazatlan, which will aid in the progress of the city.

Nearly everything used here has to be imported, and, as Mazatlan is the distributing center for a large portion of western Mexico, it will be seen that the market is a good one. The superiority of United States hardware, machinery, and electrical supplies is acknowledged by all; but German importers have steadily cut down our trade in these lines. Our trade methods have been at fault in the past. German, French, and English houses study the needs of the people. Our merchants could well afford to give longer credits to a trade as profitable as this. Wholesale firms here have abundant capital and pay cash; but the retail merchant buys on long credit, and the usual terms are six months. R. G. Dun & Co., of Mexico city, give reliable information as to the financial standing of merchants. The laws of Mexico in regard to the collection of debts are even more satisfactory than in the United States. A claim sent to a good lawyer will generally bring the desired result. No exemptions are allowed debtors. Banking facilities for collections are excellent. Charges for current commercial paper are from one to five per cent., according to amount and difficulty in collecting.

Trade in Para.—The market in Para has shown a marked degree of activity this month, says U. S. Consul K. K. Kenneday, of Para. The profits in the rubber trade have attracted the attention of foreign capitalists. The newspapers published a few days ago a cable from London announcing the formation of a syndicate with a capital of £10,000,000 ($48,665,000) for the exploitation of the rubber business. Difficulties will be encountered, however, should the syndicate, instead of making the purchase of the rubber itself in Para, attempt to buy the rubber farms. These estates are controlled by the "aviadores," men who supply the rubber gatherers with food and clothing, advancing money against the rubber to be gathered. Unless an understanding is had with the aviadores, the rubber gatherers will sell neither the farms nor the rubber.

Another smaller syndicate, formed in England for the same purpose, some weeks back, succeeded in buying a few farms in the Marajo Island, near Para; but the prices were excessively high—some say four times as much as anyone else would give, and more than double the amount of their value.

It is reported that Mr. Otto Fuerth, who some six or eight weeks ago purchased a valuable tract of rubber land in the island of Marajo for a large English syndicate, has just completed a second transaction, having purchased an estate in this section of country at the price of $1,250,000

Several representatives of other syndicates, who have made reconnoitering trips to the rubber regions of Para and Amazonas, stated, on their return, that the field is enormous; that the farther up they go, the more rubber they see; and that rubber gatherers are only working the smallest portion of the trees on their estates.

The total quantity of rubber received at this port during the month of February already aggregates upward of 4,000 tons, and it now seems positively certain that before the end of the month the figures will exceed 5,000 tons, or nearly double the amount ever before received at this port during one month. This most extraordinary movement has given room for the wildest speculation. Prices have gone up and down. Every business house is heavily loaded with orders.

The Red Cross steamer "Camatense," which bears this report, is carrying a record-breaking cargo of rubber. She arrived here from Manaos with a trifle over 400 tons on board, and she is to take 900 and odd of the 4,000 tons of rubber now in Para waiting for room in the steamers bound for New York. This total of over 1,300 tons is nearly double the amount usually shipped by a single steamer.

Both of the two steamship lines plying between New York and Para have, since the first of the year, added two steamers to their fleets. This development of transportation facilities is much needed. Not only are the river lighters filled with rubber left behind in Para, but, I am informed, scarcely a steamer sails hither from New York without leaving on the dock a quantity of merchandise which found no room aboard for Para and the Amazonas.

The delay in the exportation of staple articles from the United States to Para hurts the business relations between Brazilian merchants and American manufacturers. It is the great importance of these facts that impels me to touch once more on this subject, of which I spoke in a previous report.

The Para state government has granted a contract for the establishment of a model farm. For the consideration of $50,000, the contractor is to bring to Para 1,500 Italian farm hands. The government is to pay their passages, and give the ground for the establishment of the colony. Especial attention is to be paid to the raising of fine cattle, breeding horses, sheep, etc. The gathering of rubber, however, is so much easier work and so much more profitable, that in almost every instance when an emigrant seeks the interior, he prefers to devote himself to that industry. Fifteen additional vessels have been added to the various fleets plying between Para and outer points since the first of the year, the majority of which run up the Amazon, passing through the newly explored rubber states.

Orange Boxes in Syria.—Under date of February 9, 1899, Consul Merrill writes from Jerusalem, in reply to inquiries by the director of the Philadelphia Commercial Museum, relative to the preparation of orange boxes and the possibility of introducing them in shooks from America, as follows: The wood for orange boxes is brought from Roumania. It is a very coarse kind of pine. The ordinary length of a box that will contain 150 oranges is 69 centimeters (27 inches); breadth, 34 centimeters (13·3 inches); depth, from 25 to 27 centimeters (9·9 to 10·7 inches). The wood for the side boards is 7 to 8 millimeters (0·27 to 0·31 inch) thick; for the top pieces and the partition in the middle of the box, 17 millimeters (0·6 inch). The market price for the wood for an orange box is from 68 to 70 centimes (13 to 13·5 cents); the expense for making and nailing the box is from 10 to 15 centimes (1·9 to 2·8 cents); so that a ready-made box would thus cost about 80 to 85 centimes (15 to 16 cents).

Some Swedish wood dealers have recently tried to enter into competition, hoping to control this industry, but thus far without success. If the United States should attempt to furnish these materials, the importations would have to be made just at the beginning of the season—that is, in July, August, or September. The fact that no direct line for shipping merchandise exists between the United States and Yafa, as well as the unreliability of oriental merchants, would have to be considered. The latter is a less serious difficulty than the former.

Rope Factory in Mexico.—Consul Thompson, of Progreso, on February 25, 1899, writes:

A large rope and cordage factory has been erected in the city of Merida, state of Yucatan, and is now in full operation, having, it is said, large orders for binder twine from firms in the United States. It is the first and only plant of the kind in the entire republic, and is, experts say, one of the best equipped plants of its class in the world.

American Bicycles Wanted in France.—Consul Jackson writes from La Rochelle, February 16, 1899, as follows:

There have been several demands for American bicycles at this consulate. This should be of particular interest to those makers of cycles who have no agents at Paris. Wheels with chains which could sell for $40 to $50 and chainless that could be put on sale for $70 to $80 would doubtless find a good market here.

Machetes in Paraguay.—Consul Ruffin, of Asuncion, on January 31, 1899, said:

There are two kinds of machetes in use here: One with a handle of wood, a blade of iron, and a rounded end; the other pointed, with steel blade and horn handle. The first is used for cutting weeds, the last for cutting small trees, twigs, bushes, herbs, and grass; likewise for chipping wood and making handles and articles for agricultural purposes. They are all imported, none being made in Paraguay. In 1897, the import amounted to 3,997 dozen and was valued at $8,489 gold. There is no duty. Machetes costing $8 to $10 ($1.50 to $1.75 gold) a dozen are imported from England; those costing $21, $24 and $28 ($3, $3.50 or $4 gold) a dozen, from England and Germany; those costing $65 ($9 gold) a dozen, from the United States. Terms of credit are six months. Banking facilities with the United States are by means of the Mercantile Bank, which has an agent in New York city. Since the United States will probably supply machetes to Cuba and Porto Rico, it may be able to obtain a share of the Paraguayan trade as well.

Chart of Russia at Paris Exhibition.—Under date of February 27, 1899, Consul Smith, of Moscow, writes: An extensive chart of Russia is to be exhibited at the Paris Exposition, on which will be shown the extent of different trades in Russia. The above chart will be prepared by a commission appointed by the pedagogical department, and will show the different trades taught in the Russian schools, such as wood carving, mechanical work, art, etc.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

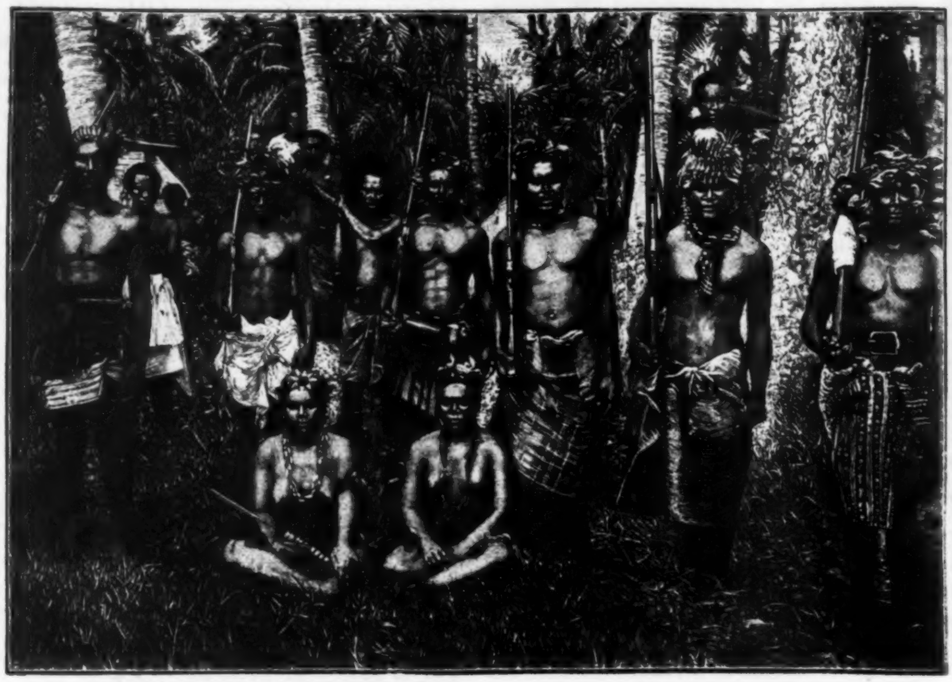
THE SAMOAN ISLANDS.

The people, productions, and commercial and strategic importance of the Samoan Islands are discussed in the current number of the Monthly Summary of Commerce and Finance, just issued by the Treasury Bureau of Statistics. The islands are located about 2,000 miles south and 300 miles west of the Hawaiian Islands and 14° south of the equator. They lie in an almost direct line between San Francisco and Australia and slightly south of the direct steamship line connecting the Philippines with the proposed Panama or Nicaraguan interoceanic canals. Their special importance, therefore, lies more in their position as coaling and repair stations on these great highways of commerce rather than in their direct commercial value, their population being small and their imports and exports of comparatively little importance.

The group consists of 10 inhabited and 2 uninhabited islands, with an area of 1,700 square miles and an aggregate population, according to latest estimates, of 36,000 people, of which something over 200 are British subjects, 125 Germans, 25 Americans, 25 French, and 25 of other nationalities, while the remainder are natives, of the Polynesian race. The bulk of the population is located in the three islands of Upolou, Savaii, and Tutuila; the number in Upolou being 16,600, in Savaii 12,500, and in Tutuila 3,700. The islands are of volcanic origin, but fertile, producing cocoanuts, cotton, sugar, and coffee; the most important, however, being cocoanuts, from which the "copra" of commerce is obtained by drying the kernel of the cocoanut, the "copra," which is exported to Europe and the United States, being used in the manufacture of cocoanut oil. The exportation of copra from the islands in 1896 amounted to 12,565,909 pounds, valued at $231,372. A considerable proportion of this was exported to the United States; a larger proportion, however, to Germany, whose citizens control its commerce through a trading company which has long been established there. The cocoanut and copra production, however, varies greatly from year to year, owing to the fact that many of the cocoanut trees have been destroyed in recent wars between native factions, a single individual being able, by cutting out the crown of the tree, to permanently destroy in two minutes' time the fruit-bearing qualities of trees which require several years for their growth.

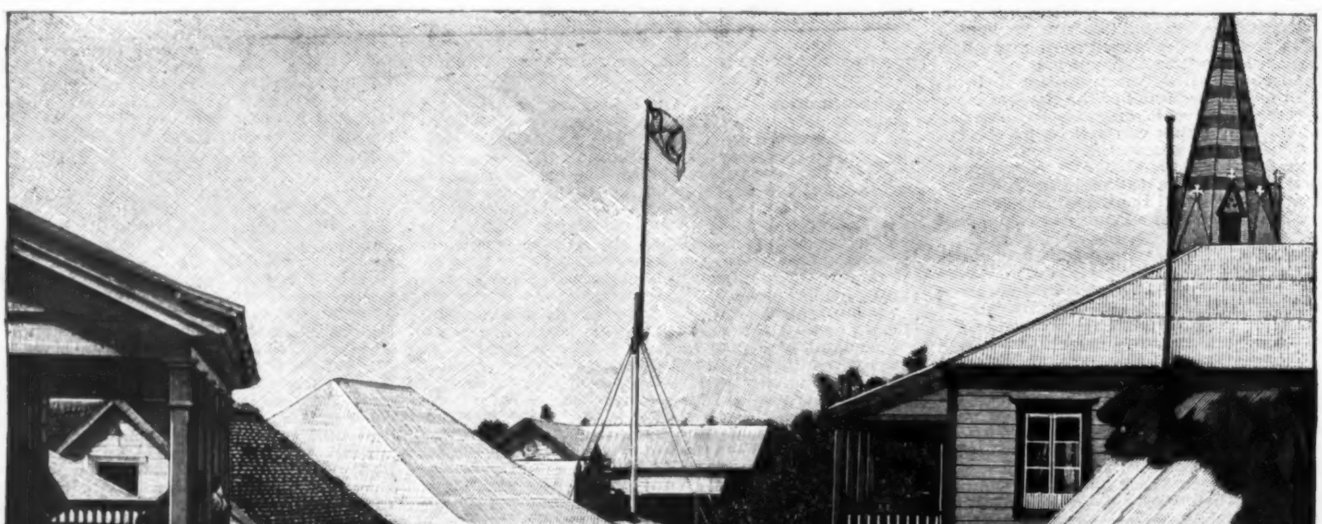
The government of the Samoan Islands had been from time immemorial under the two royal houses of Malietoa and Tupea, except on the island of Tutuila, which was governed by native chiefs. In 1873, at the suggestion of foreign residents, a house of nobles and a house of representatives were established, with Malietoa Laupepa and the chief of the royal house of Tupea as joint kings. Subsequently Malietoa became sole king. In 1887 he was deposed by the German government upon the claim of unjust treatment of German subjects, who formed the bulk of the foreign population on the island, and was deported first to German New Guinea and then to the Cameroons, in Africa, and finally in 1888 to Hamburg, Tamasese, a native chief, being meantime proclaimed by the Germans as king, though against the protest of the British and American consuls at Samoa. Mataafa, a near relative of Malietoa, made war upon Tamasese and succeeded to the kingship.

In 1889 a conference between the representatives of the American, British, and German governments was



SAMOAN WARRIORS AND "VILLAGE MAIDENS."

held at Berlin, at which a treaty was signed by the three powers guaranteeing the neutrality of the islands, in which the citizens of the three signatory powers would have equal rights of residence, trade and personal protection. They agreed to recognize the independence of the Samoan government and the free rights of the natives to elect their chief or king and choose a form of government according to their own laws and customs. A supreme court was established, consisting of one judge, who is styled the chief justice of Samoa, and who is at present W. L. Chambers, an American, formerly a resident of the State of Alabama. To this court are referred: First, all civil suits concerning real property situated in Samoa; second, all civil suits between natives and foreigners or between foreigners of different nationalities; third, all crimes committed by natives against foreigners or committed by such foreigners as are not subject to any consular jurisdiction. The future alienation of lands was prohibited, with certain specified exemptions. The capital was located at Apia, the chief town of the group of islands, and a local administration provided for the municipal district of Apia. A commission was appointed to investigate titles to lands alleged to have been purchased from the natives, and this in 1894 completed its labors, confirming about 75,000 acres of land to Germans, 36,000 to British, and 21,000 to Americans, though much of this land has since changed hands. Malietoa, who



STREET IN APIA, WITH SAMOAN WARRIORS.

had been deported, was restored as king in November, 1889, and continued as such until his death, which occurred August 22, 1898, when the consuls of the three powers, with the chief justice as president, took charge of the administration pending the election of a successor. It is out of the election and recognition of this successor to King Malietoa, deceased, that the recent disagreements between the representatives of the three governments maintaining the joint protectorate over the islands have occurred.

A speedy adjustment of affairs and a uniform government is most desirable for the colonists as well as for the harmless natives. Although the natives liked the sport of war as formerly conducted by them, from our point of view they are a very peaceful people, and heretofore foreigners have never had to suffer from long continued disturbances. The Samoans conducted war in a manner that was more ceremonious than warlike, although the warriors prepared for battle by decorating their faces with soot, hoping thus to make themselves appear as warlike as possible, and the same custom was followed by the so-called "village maidens," upon whom the duty of beheading the conquered enemy formerly devolved. But these customs of the natives have been much changed.

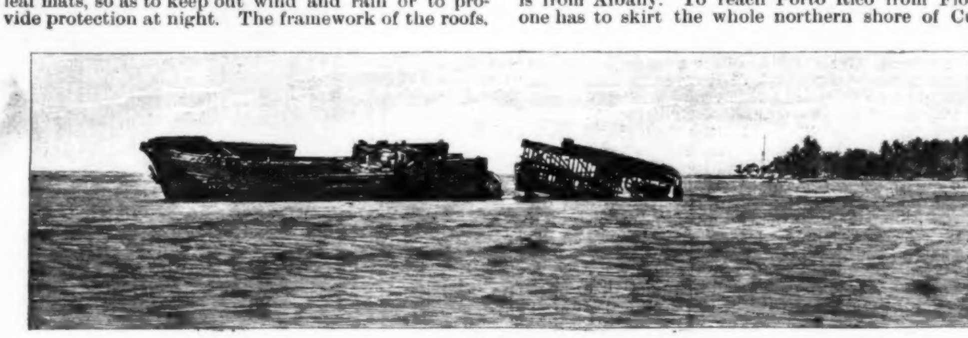
One of our engravings shows part of the foreign colony on the long tongue of land of Mulinun, which bounds the semicircular harbor of Apia on the west. On this peninsula also stands the palace of the late king, Malietoa Laupepa, a simple wooden house with a little veranda like the dwellings of the white people; and near the beach stands the house of the president of the municipality, Dr. Raffel, which played an important role in recent events.

The huts of the natives, which are shown in another of our engravings, are generally surrounded by an inclosed yard which is paved with selected small pieces of lava, or lava that has been broken up. The floors of these dwellings are also of this material, over which firm mats woven from pandanus or palm leaves are spread, thus covering the sharp corners of the stone and making the floors comfortable to lie or sit upon. The houses rest on central and outer posts, and the space between these can be shut off by means of palm leaf mats, so as to keep out wind and rain or to provide protection at night. The framework of the roofs, which is generally covered with leaves of the sugar cane, is very strong and skillfully put together.

NATIVE HUTS ON MULINUN.

The harbor of Apia is surrounded by coral reefs which rise vertically from the bottom of the ocean, and at low tide their varied forms and rough and sharp projections can easily be seen. These reefs have caused many shipwrecks. During the terrible storm of March 17, 1889, the German cruiser "Adler" was driven upon one of these reefs, which still holds the wreck in spite of all the efforts that have been made to remove it. It has been reduced almost to a skeleton, partly by work with the ax and chisel, and partly by the wear of time. At the same time the gunboat "Eber," the American vessels "Trenton" and "Vandalia," and nearly a hundred brave German seamen were lost.

The Samoans, who spend the greater part of their time on or in the water, know these reefs most thoroughly. With their canoes and pretty, slender boats, which they generally build for themselves, they sail or row both inside and outside of the belt of reefs with the greatest safety. Their boats are their pride, and their ambition to own the longest and fastest boat opens a good field for shipbuilders and dealers in sawn wood, for there is no saw mill in Samoa. The white boats manned with forty or fifty brown or uniformed oarsmen gliding along the shore at high tide under an even stroke are a fine sight. The uniform of the crews shown in the engraving is the invention of traders who knew how to cater to the fancy of the natives, but it cannot be said that the appearance of the finely built Samoans is improved by it. The natives are seldom seen in their original costume (which consisted chiefly of tattooing), for the men as well as the women, of those regions, at least, which are most visited by foreigners, wear a skirt-like garment (the lavalava) fastened about the hips, and a light jacket. Nevertheless, most Samoans of sixteen or more are still tattooed, in spite of the painfulness of the process—which is performed by means of a fine sharp comb made of bone, and a liquid prepared from nuts—and the opposition of the missionaries. We are indebted to the Illustrirte Zeitung for our engravings.

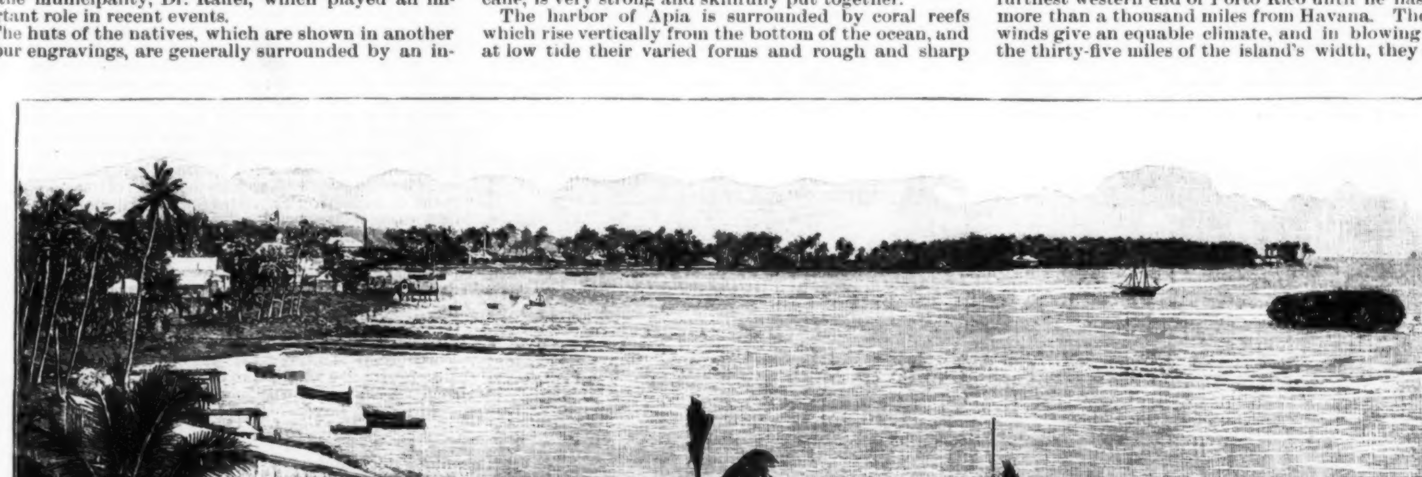


WRECK OF THE GERMAN CRUISER IN APIA HARBOR.

PORTO RICO, THE LAND AND THE PEOPLE.

By WILLIAM HAYES WARD, D.D., LL.D.

THAT Porto Rico will become a winter resort, like the Bermudas, I cannot doubt. Already the bold ridge across the bay from San Juan has been selected by public consent as the fit site for a great hotel like those in Florida. But first there will need to be speedier and more frequent steamship service. Porto Rico has great advantages in climate and scenery to attract visitors. Because it stands far out into the Atlantic, it catches the full benefit of the steady trade winds. Cuba pushes its western point into the Gulf of Mexico, about as far south from Florida as New York is from Albany. To reach Porto Rico from Florida one has to skirt the whole northern shore of Cuba, then sail past Hayti, and he will not catch sight of the furthest western end of Porto Rico until he has sailed more than a thousand miles from Havana. The trade winds give an equable climate, and in blowing across the thirty-five miles of the island's width, they cannot



VIEW OF APIA, WITH MULINUN.

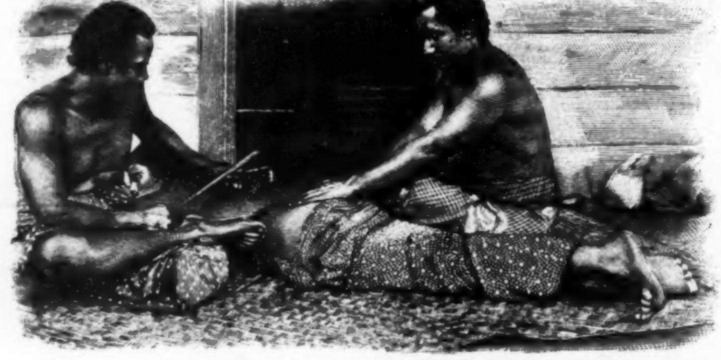
become heated, as they must rise four or five thousand feet to cross the mountains, which make the backbone of the island. The temperature in winter every day reaches about eighty degrees, and ninety-two degrees is the extreme limit of summer heat. The nights are

UNIFORMED SAMOAN BOATMEN.

never sultry. Through the winter the sky remains beautifully clear and blue, cumulus clouds float about the horizon day after day, occasionally shading the sun or even giving a brief spit of rain, which may become a smart shower on the hills. The air is not dry, nor is it too moist; it stands at about seventy-five per cent. of saturation. No winter visitor could have anything but praise for the Weather Bureau man of Porto Rico.

Then the island is one of the most beautiful in the world. It is about two-thirds the size of Connecticut, and nearly the same shape, three times as long as it is wide. The mountains rise from the coast, leaving no sandy barrens and almost no stretches of marsh. The lower swales and valleys afford rich fields for pasture or for sugar cane. On the knolls are orchards of cocoanut; about the houses and huts are groves of bananas; on the hills, to their summits grows the coffee, protected by the shade of small trees. This coffee is of a high quality, and is all absorbed by the European market. There is grass everywhere, densely matted and low, or where cultivated growing half high enough to cover the big cattle. The absolutely clear sky, without smoke or haze or dust, the constant verdure, the tropical vegetation, the beautiful mountain scenery, make Porto Rico one of the most attractive spots on the face of the earth.

But it needs roads. There is only one road on the island that deserves the name, that from San Juan to Ponce, and that is perfect. The patches of railroad hardly deserve the name. The visitor is in trouble whenever he tries to travel, and business is utterly checked. You land at San Juan, nearly at the eastern extremity of the northern coast, and try to go about the island. You have to take the daily train, which starts at six o'clock in the morning, on the narrow-gage railway. By nine o'clock traveling west, you reach the considerable town of Arecibo, near the middle of the northern coast, and an hour or more later you reach Camuy, the end of the route. There a carriage meets you, which will carry three passengers, but the seats are already engaged, and you go to the "hotel," and wait for two hours while the proprietor sends out into the country to get horses for another carriage. At last you are started for Aquadilla, where you can again take the train. The tough little horses are lashed all the way. You are lucky, for it is winter, and there are not many deep, black, mud holes, or the road would be utterly impassable. You go crashing up hill and down, over rocks, tipping into ruts, wondering that the stout carriage does not break, and that the driver's whip-arm is not lame. The road, if it has ever been made, has been repaired only by the winter torrents. You find streams which must be impassable rivers in the rainy season, and at every ford you note the women washing their clothes, and you wonder if this is the water which supplies the towns below. You change horses after some three hours of this torture, and the same lashing at last takes you into the streets of Aquadilla, but the poor beasts can go no further, and you have to jump into another carriage, and a swift drive takes you to the station, always a mile or two out of town, where you are lucky to catch the evening train, which will carry you twenty miles to Mayaguez. Ah! but will you not have to suffer in Purgatory for allowing those horses to be thus lashed without cessation all those hours? And yet, how can you at once reform the four-century-old customs of a people who could understand neither your language nor your sympathy for brute beasts?



TATTOOING PROCESS.

You have now reached Mayaguez, the most beautiful city in Porto Rico, situated at its extreme western end, a city with broad streets, fine houses, and much wealth. Somehow its people have escaped the worst evils of Spanish oppression, being furthest from the center of government. But there is no railroad the other side of Mayaguez; you must again take a carriage and risk a smash-up here and Purgatory hereafter. Five hours of galloping and creeping, of sinking and swaying and tumbling, takes you to Yauco, a town half of whose inhabitants climb like goats to their little dirty huts of palm-leaves and thatch on the steep side of the hill, and whose alcalde, educated himself in Spain and Belgium, does not want any American schools. The next morning an early train will take you to Ponce, the second city on the island, and which has an even larger American population, I think, than San Juan. You have now ridden over nearly every mile of railroad on the island, and you have driven, or been driven, over two of the best roads, always excepting the famous military road which will take you from Ponce to San Juan. Had you attempted to drive from Arecibo into the interior to visit the beautifully situated and beautiful town of Utuado, second only in the enterprise of its people to Mayaguez, you would have been wise to take no carriage, but to trust your weight, if not too heavy, to the back of a horse selected for its size; and you would have fared worse if you had tried to go to any other interior town off the military road.

But a day, or better two days, on that road is a memory for a lifetime. What could it have been but military needs that could have led the Spanish government to bestow such a boon? The engineering is wonderful. The road has to cross mountains, rising ridge after ridge to a height of four thousand feet, and yet there is not one steep ascent, not one hill where the horses cannot comfortably trot, not one rise that would delay the passage of heavy cannon. It is all perfectly macadamized, wide and easy. It winds up and up, hugging close to the hills covered with coffee, looking down into the near valleys, with their patches of tobacco and their banana groves, over bridges and arches, bearing, perhaps, an inscription, telling in English that they were repaired by one of General Miles' regiments, after having been blown up by the Spaniards. The views of green mountains and deep valleys; of cocoanut, palm grooves, and the slenderer and more beautiful royal palm; of rustic cabins surrounded by breadfruit trees and bananas; the rocky cliffs under which you pass, spattered with the silver-fern; the hedges of cimetared agave, and the unknown vines and flowers; the occasional compact towns, with their blue and yellow stuccoed houses, their plazas laid out with flower-beds and speckled with crotons, and their great domineering churches—all this under such a sky, and fanned by such a breeze, makes the day ever memorable in which you ride back from Ponce to San Juan.

CORAL REEFS AT LOW TIDE.

But the first thing that Porto Rico needs, after the first task of sanitation is done, is other roads. We know how good roads have replaced the ox teams of our New England fathers by the draught horses that now pull our plows and wagons. All farm work in Porto Rico is now done by man labor or ox labor. The horses are small, but the oxen are large, the cows nearly as large—hardly a hundred pounds less in weight—and they have somewhat of the Jersey look. The oxen are not yoked, but pull their great carts by a stout bar tied in front of their horns. Only the slow-stepping oxen could draw the unwieldy carts loaded with bags of coffee over such drunken roads from the hills to the coast. There can be no easy commerce, no opportunities for the poor people, no chance for general civilization, till there are roads that can be traveled, railroads, trolley roads, macadamized roads, dirt roads, anything and everything that will make intercommunication possible; and those roads, I believe, of all sorts, in such a tight little island should all be owned by the island itself. With roads to carry produce there will be vastly more produce to carry. Not an orange is now exported; they are generally picked from trees that grow wild, and any choice of varieties is hardly known; yet Porto Rico might supply half the country with oranges, with no fear of frost, and as yet no scale.

But as you have walked the narrow streets of the Porto Rico cities, you have looked most at the people, for I will give you the credit to assume that you are not there to squeeze or scrape money from the island, but to consider what good you can do its inhabitants. As you scan the well-to-do and the poor who fill the streets and the markets, as you peer into the crowded tenements into which the ground floors of pretentious houses are converted, as you wander about the edge of the horribly squalid quarter of Arecibo, where the

poor are crowded in their palm-shacks as you never saw them crowded before, or through the more scattered huts that cling to the side of the hill that overlooks Yauco—wherever you meet the people you find two types, I might say two only. There are those of pure Spanish blood, natives of Spain, some of them, that have not yet returned, and their pure-blooded descendants. Such are most of the proprietors of estates, the merchants, the men of property and position, those that make society. While there is no color line drawn in church or school, nor any visible to the careless observer, one learns that there is a social line drawn. Only white people will be seen at the principal social functions. Others are not invited nor expected to attend the receptions given by high officials. Until our troops came only white people were, by unwritten law, allowed to be in the plaza on Sunday and Wednesday evenings, when the band played and, as in a sort of cattle show, the marriageable young girls in their handsomest array walked bareheaded forward and back between rows of admiring swains. Many of these white men, the best of them, have been educated in the United States and speak English.

But the great mass of the people are of mixed blood and appear to have reached, in the course of more than four centuries, a nearly fixed type. One sees very few black people, and these mostly late comers, from St. Thomas and Antigua, who speak English. There are possibly a dozen very old persons said to be pure Indians on the island. I heard of one such. But the working people are of one color, a light brown, with regular features, nose not flattened, and with hair black and perfectly straight or slightly wavy. They seem to me to be more Indian than negro, and with as much white blood as of the Indian and negro combined. They are rather small in stature, thin and lithe, erect, and the women show a fine carriage. There is none of that cowed, cringing manner which we sometimes notice among our own negroes. They are alert in body and mind, not lazy, and the children are quick to learn. But there is not one schoolhouse on the island, the schools are in the houses where the teachers live, and for three-fourths of the people no school privileges are provided. Of course, they are ignorant. They are not vicious, not given to drunkenness nor to crimes of violence; they are simply untaught and have not really learned enough to be discontented with a lot which we would call a spiritual hell in a material paradise. They can only starve on their wages, and their food is bananas and other fruit which will supply no rich blood. It is no wonder that they are anæmic as well as ignorant. They live in a fair degree of social morality, if we can call those married who live together and rear their large families with no church sanction of marriage, for three-fourths of the unions have been blest with no ceremony. The people desperately need both religious and intellectual education. American Christians must give them this. They are not brutes, they are not inferior naturally. Their educated men, both white and colored, are fine people, who excel in intelligence and courtesy. They can make good citizens of our republic.—The Independent.

LAND TENURE IN RUSSIA.

THE chargé d'affaires ad interim at St. Petersburg, Mr. Peirce, writes, under date of November 15, 1898, in regard to the shortage of crops in Russia. This is partly to be ascribed, he says, to the thriftlessness of the peasant class, which thriftlessness has been variously attributed to climatic influences, to intemperance, to administrative methods, to the former condition of servitude, to the mir or communal system of land tenure, etc. The last named cause especially, Mr. Peirce thinks, would be sufficient to explain a general lack of self-reliant industry among the people. He continues:

The land of the peasantry is not generally owned by them individually, except in certain districts of the Baltic provinces, of Little Russia, and of Poland, but is held by them in communities or mirs, in which each tax-paying individual has a share and for the taxes of which he is responsible. The taxes due to the government are assessed upon the number of "souls" in the community, and upon the same basis is allotted to it a certain quantity of land. This land is sold, not given, to the mir, and payment therefor is made by amortization from a certain proportion of the taxes. For these taxes the mir is held strictly and rigidly responsible, but it is permitted to collect the amount from the individuals of the community as it may see fit—of course, within certain restrictions. The mir, therefore, constitutes a community having a considerable degree of self-government. It elects its officers by popular vote and regulates its own financial affairs, in which it is not molested by the imperial government so long as it continues to make its full tax returns. To each "soul" is allotted by the authorities of the mir a certain proportion of land of three separate sorts, viz., cultivable, pasture, and marsh or meadow, according to his ability to work the land productively in the interest of tax payments. Thus a man who has a horse is given more land than he who has not, while one who has able-bodied children—sons or daughters—is given more than the man who has no one to help him in his cultivation, the incapacitated being given nothing, but supported by the community. In these allotments the ownership of the land does not pass to the individual; he is simply given the usufruct for a certain term, and the duration of that term varies in different mirs from one year to ten or even more—from three to five being the most usual—with a general tendency to increase the length of the period. In this allotment the individual has no option. He may argue his case before the board of officers of the mir; but he must, perforce, assent to accept the allotment of land made him, together with the share of taxes devolving thereon. In general, it is said that these apportionments are made in a spirit of equitable fairness, but that abuses do exist is not surprising. It occasionally happens, for instance, that a peasant having a reputation for expertness at some trade which brings him custom from the neighboring large proprietors or from other points outside the limits of the commune, by means of which he earns money in excess of what his labor in the fields could produce, has fastened on him an excessive proportion of communal land and consequent taxes.

While in the more productive districts, and especially in the black earth belt, the effort on the part of the individual is to secure as much land as possible, in the northern and other unproductive districts the peasant tries to shirk his communal responsibilities by presenting reasons why he should be allotted the minimum of land.

Not infrequently the peasant seeks employment in the cities, either for the entire year or, what is still more common, for the winter months only. This may happen owing to one or more of several causes. He may be sent by the head of the family to which he belongs to earn money to assist in paying the joint share of their communal taxes, his allotment of land being, if the absence is during the summer season, operated by the other members of the family, or he may, upon his own account, desire to add a little to his income, or even, finding his land unprofitable, he may abandon its cultivation to seek a livelihood in the city; but whatever may be the cause of his absence from the mir, he does not escape his responsibility for the taxes. For, while the central government permits the mir to collect the taxes from the individual, it also assists it in so doing by keeping track of him, and by returning him to the mir, in case of his failure to remit his share, and even by inflicting punishment when the resources of the mir in that respect fail to compel him. Still further, the complaint of the head of a family to the mir that an absent member is not remitting his share of the taxes on the family allotment may cause the delinquent's arrest and return to his commune.

Individuals who misbehave themselves in the city may also be sent back to their mir by administrative process. Thus I have myself seen an insolent and intractable servant brought at once to perfect submission by the threat of reporting him to the police and requesting his return to his commune. To render possible this control of the individual requires a very careful system of enregistration. Thus, on taking up a new habitation, every sojourner and inhabitant in a city must be duly inscribed in the books of his police district, and for such enregistration the proprietor of the house is held accountable. As it not infrequently happens that the peasant or "mujik" knows no other than his baptismal name and that of his father, and sometimes not even the latter, the difficulty of keeping track of individuals can be imagined. Ivan Ivanovitch (John, son of John), of such a mir, may be, and not infrequently is, the sole designation he can give himself, and perhaps, even, he can only say that he is John, son of a soldier. But the name of the mir to which he belongs is inscribed on his passport when issued to him, and without this document he is not permitted to remain in any city; nor, indeed, is it easy for him to find any abiding place.

It will be seen, therefore, that the mujik is closely bound to the soil through the medium of his mir. But further, the mir is obliged to take care of him. It can, while he is able to labor, force him to pay his share of the taxes; but if he becomes incapacitated, it must at least keep him from starvation.

The house of the mujik does not stand in the middle of his little farm, but in the village street, and this building, with its small surrounding lot, belongs to him or to his family; but the productive land lies sometimes versts away from the village and consists of a long, narrow strip, or perhaps several of such strips, apportioned with a view to giving to each "lot" an equal share of the best and of the poorest soil.

The inevitable result is that the mujik, feeling that, at the end of a period more or less brief, his allotment will be subject to a redistribution, in which, if he has improved it by careful cultivation, expending upon it time and money with an eye to the future, the greater part of it will probably be taken from him, puts into his land only such cultivation as will give him, for the existing season, the best returns, without expending upon it capital or labor of which he is not to enjoy the full fruits. Hence he plows but the top of his soil, not only to save labor, but that his manure may be consumed by his own crop and not by a future one. He has no attachment to the soil to which he belongs, but which does not belong to him, and he is devoid of that self-reliant independence which characterizes the agricultural classes of other countries. If we add to this the absolute fatalism with which the mujik regards every event of life, whether of good or evil fortune, we have, it would seem, a combination of temperament and surroundings well calculated to develop thriftlessness.

In those parts of Little Russia, the Baltic provinces, and Poland, where the mir system does not exist, not only is the peasant more animated and cheerful, but much greater thrift prevails.

It is now some months since the attention of the Emperor was directed to the unfortunate condition of things existing in many of the agricultural districts, and he has directed, not alone that material aid from his privy purse be liberally extended, but that full and exhaustive reports upon the entire condition of the peasant in the various parts of the empire be furnished him, with a view to discovering the exact state of affairs, and, if possible, the true causes to which are to be attributed the alleged distress, with a view to its intelligent amelioration.—United States Consular Report.

ESTIMATION OF CARBON AND HYDROGEN IN VOLATILE ORGANIC LIQUIDS.

By F. W. STREATFEILD, F.I.C., and LEWIS EYNON.

IT is well known that, in the estimation of carbon and hydrogen in liquids that boil or vaporize at a low temperature, many practical difficulties are met with. When the substance contained in a glass bulb is manipulated within the combustion tube very great care must be taken to prevent too rapid expulsion of the liquid from the bulb, otherwise failure results from incomplete combustion and backward diffusion. Again, when the substance is contained in a small sealed tube outside the combustion tube, a great deal of experience and dexterity is required in breaking the ends of the tube and preventing loss.

Having occasion recently to undertake the estimation of the constituents of some volatile organic liquids, we have devised the following little apparatus, which, we believe, will greatly simplify operations of the kind here under consideration. Reference to Fig. 1 will, we hope, render the construction of the apparatus evident.

It consists of a moderately large test-tube, preferably made from thick glass tubing fitted with a caoutchouc stopper pierced with three holes. Through one of these a glass tube passes; this is connected with the air or oxygen supply, and just dips under the surface of some mercury placed in the tube. Another glass tube connects the apparatus with the combustion tube. The third hole carries a glass rod bent over or flattened at one end. The glass rod may be made to slide in a glass tube, supported and made airtight by a piece of well fitting caoutchouc tubing, as shown in the sketch.

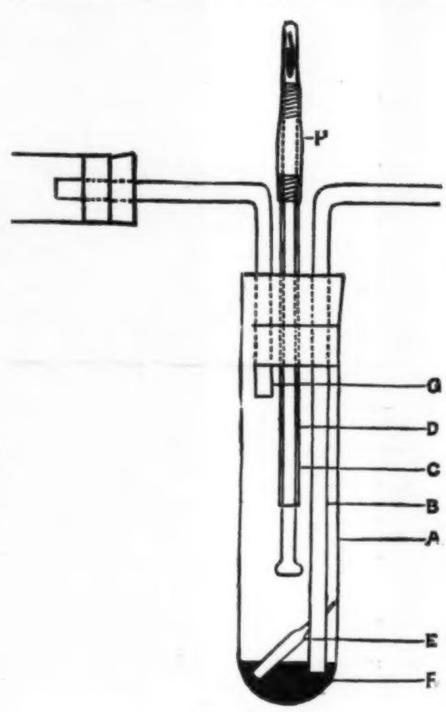


FIG. 1.

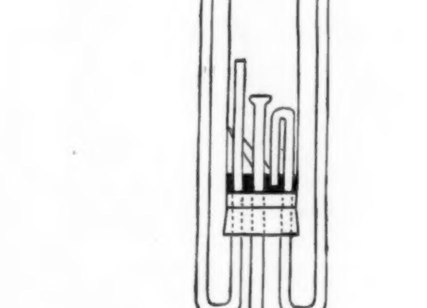


FIG. 2.

The method of using the apparatus requires little or no explanation. The substance, contained in a sealed thin glass bulb, is placed in the test-tube, the stopper inserted, and the apparatus connected to the combustion-tube. Everything being in order, the glass tube is broken by pressing down the rod, and the vapor slowly and carefully expelled by the current of air or oxygen. Toward the end of the operation the apparatus may be surrounded with hot water contained in a beaker. It will be seen that, by means of the mercury trap, there is little or no possibility of the vapor of the substance diffusing backward, and, if the current of air be carefully regulated, complete combustion results, provided, of course, there is a good length of copper oxide in the combustion tube.

In cases where, owing to the nature of the vapor, the caoutchouc fittings may be attacked, we propose the following modification (see Fig. 2); it consists, as will be seen, in simply inverting the test-tube and bending the air supply tube over on itself, so that the end of the tube dips under the surface of the mercury which covers the caoutchouc stopper.

Of course a more elaborate apparatus might be constructed by fusing the entrance and exit tubes into the sides of the test-tubes.

We append the following results obtained with the apparatus in the combustion of petroleum ether:

	Carbon.	Hydrogen.	Total.
1.	83·57 per cent.	16·44 per cent.	100·01 per cent.
2.	83·337 "	16·578 "	99·915 "

We regret that we are unable to publish further results, as, unfortunately, our work has been interrupted. We venture, however, to submit the foregoing, incomplete as it is, hoping it may be sufficiently interesting and suggestive to induce others to experiment with our apparatus.—Chemical News.

AUTOMATIC INTERRUPTER UPON HIGH TENSION CIRCUITS.

HIGH tension and alternating current distributions have the advantage of supplying subscribers through the intermedium of transformers, which, in most cases, are placed in the subscriber's house. The high tension circuit enters the cellar, wherein is located a transformer. The apparatus is placed under lock and key, and the distributing company alone has charge of it. A low tension distributing circuit enters the occupied portion of the house, and the subscriber is therefore shielded against the various inconveniences that might attend the use of high tension. But if, for a moment, we examine the interests of the distributing company, we shall see that the transformers will be constantly connected with the primary circuit coming from the works, and that they will always be consuming a certain amount of power even when idle, and during the day a certain amount of energy. The figures may be feeble in installations of lighting, but they will be entirely otherwise with electric elevators, which consume from two to three horse power, and with electric motors used for different purposes, and the power consumed by which will be scarcely less than that just mentioned. There is therefore good reason for taking into consideration the expense thus produced. We are able to illustrate this subject by some figures that have been kindly furnished us by M. Langlade, engineer in chief of the sector of the left bank of the Seine at Paris. An elevator transformer consumes on an average, when idle, 210 watt-hours per hour. If it operates but one hour a day, there will be an idle period of twenty-three hours. The consumption, at the end of the day, will therefore have been $23 \times 210 = 4{,}830$ watt-hours. In reckoning the net cost (actual expenses alone included) at 0·02 of a franc per hectowatt hour, we find, after twenty-four hours, an expense in pure loss of 0·966 of a franc per elevator or motor, and, at the end of the year, a total loss of 365 francs.

It would hence be of interest to find an apparatus that would permit of suppressing the transformer when the elevator or motor was not running, and of re-establishing it when the contrary was the case. It was with such an object in view that the Compagnie Française d'Appareillage Electrique constructed the apparatus which we are about to examine. The automatic interrupter of which it is a question is placed upon the primary circuit of the transformer. It is closed while the elevator is ascending and opened while it is coming down. So, too, it is closed when a motor begins to run and open when it stops. These operations are performed automatically through the intermedium of a local electric circuit controlled by the elevator or the motor itself.

The interrupter, properly so called, is formed of a silver plated copper rod, of which the two extremities are bent back, as shown in Fig. 1. This rod is carried by a movable insulating piece which, in the figure, is seen raised. Beneath there is a block of insulating material, which is provided with terminals to the right and left. Upon the terminal to the left, in front, is fixed a small strip of silver plated copper, and upon the other terminal, in the rear, there is fixed a similar strip. With this last named terminal there is connected a cable of the primary circuit, which, to the left, traverses an ebonite tube, *G*. To the right of the small base there is another terminal in front of which there is a small cup, *F*, filled with mercury. With this terminal is connected another cable that makes its exit from the tube, *H*. When the bent silver plated copper rod descends, it bears upon the two strips above mentioned, while, at the same time, the two extremities enter the mercury cups. The junction of the two cables is thus assured through the contact of the strips and through the mercury.

The stationary piece around which the axis carrying the metallic rod is movable is provided with a guide in which slides the extremity of a rod, *E*, movable around an axis and fixed at *D* to another rod.

The pieces that collectively serve to establish the contacts enter a glass containing castor oil, in which breaks are obtained without sparks.

At the upper part of the apparatus, at *D*, there is a rod, which is movable around a central point and carries an electromagnet, *C*, at one of its extremities. Its other extremity is connected with the piece, *E*, of which we have already spoken. At *A* and *B* are two other electromagnets which, as well as *C*, are supplied by local batteries. The electro, *C*, always preserves its pole, but the electros, *A* and *B*, change their extreme pole according to the direction of the current sent from the exterior. At the starting or stopping points of the elevator there are, in fact, commutators that either do or do not send the current of the local batteries into the circuits of the electromagnets.

It is now very easy to understand the operation of the apparatus. Fig. 1 shows the interrupter open and the primary circuit cut off. If, at any point whatever, we close a commutator in order to send the current into the electro, *A*, so as to form a pole of a character contrary to that which it possesses, the electro, *C*, will be attracted to the electro. *A*. The pieces, *D* and *E*, will be set in motion and the metallic piece will fall and bear against the strips of copper and enter the two mercury cups, and the primary circuit will be closed.

We can, in the same way, very easily perform the contrary operation for opening the interrupter. By means of the commutators already mentioned, we send the current from the local battery into the electromagnet, *B*, when there will be immediately formed a pole of a contrary character which will attract *C*. The rod that supports this latter pole will be immediately set in motion and carry along with it the jointed rod, *E*, and the latter in turn will raise the piece that carries the metallic part. The small rods will be drawn from the mercury at *F*, a spark will leap in the castor oil, and the circuit will again be opened.

Fig. 2 shows the installation of the automatic interrupter upon the primary circuit of a transformer in a compartment arranged especially for the purpose in a cellar, and upon the system of the sector of the left bank of the Seine at Paris. At *A* may be seen the exterior cable, which, at *B*, enters the circuit breakers of the company. A wire makes its exit at the left and traverses the interrupter, *C*, placed against the wall, through which it passes in order to join the second wire upon the primary circuit of the transformer, *D*. The wires of the secondary circuit make their exit in front and run upward in order to supply the house.

This automatic interrupter is employed in numerous installations in the sector of the left bank of the Seine, as well as in the sector of the Champs Elysées. Up to the present it has given very excellent results, and there is every reason to believe that it will render genuine services in the distribution of electric energy through transformers.

For the above particulars and the accompanying illustrations we are indebted to La Nature.

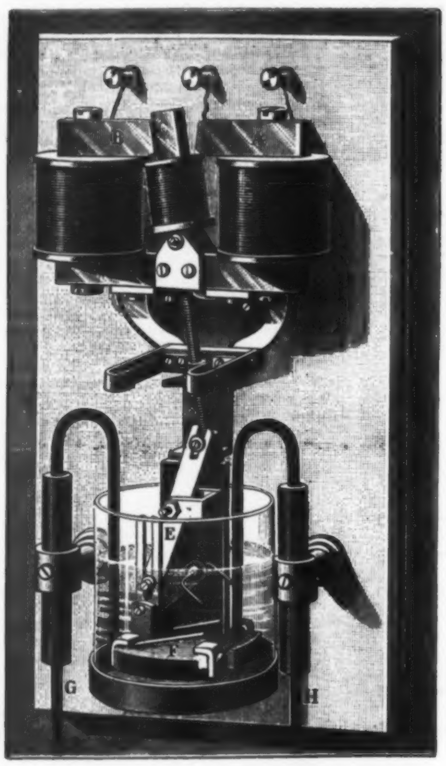


FIG. 1.—DETAILED VIEW OF THE AUTOMATIC INTERRUPTER.

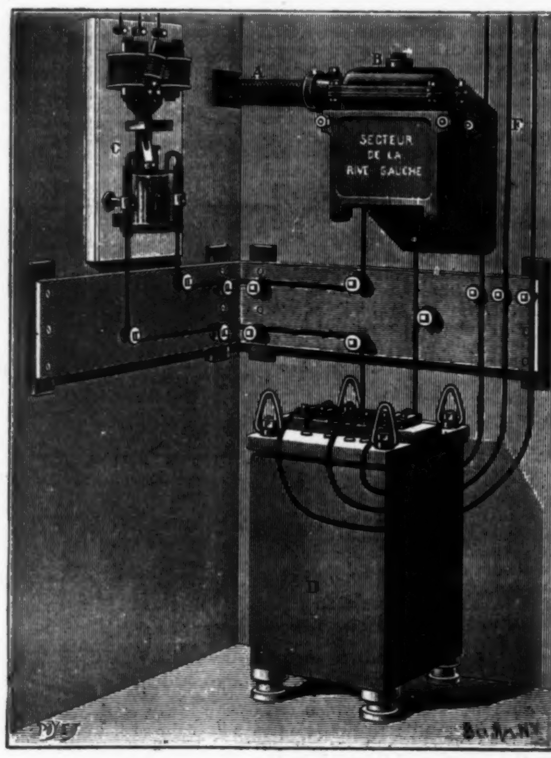


FIG. 2.—INTERNAL VIEW OF A COMPARTMENT CONTAINING A TRANSFORMER AND INTERRUPTER.

ARITHMETIC AMONG THE ANCIENT EGYPTIANS.

THE mighty engineering works of the ancient Egyptians make us think of them as expert mathematicians. We are surprised, therefore, when the methods set forth in their recently translated manuscripts make them out rather clumsy at arithmetical calculation. This is explained by a contributor to Der Stein der Weisen (which is translated by The Literary Digest) by the fact that the nobility and the priesthood kept their knowledge secret. We translate below what he has to say on the subject:

"Almost all ancient civilized peoples had this common peculiarity—they did not understand perfectly how to make use of their theoretical knowledge. This depended partly on the fact that this knowledge, mathematics for instance, was a formal secret cult, and that the acquirement of it was allowed to a small number of initiates only, while the common, practical man was only instructed in it so far as was deemed proper by the high priests of its mysteries or so far as it was clearly understood by them.

"That the Babylonians, Hindoos, and especially the Egyptians, has made great progress in geometry, is not to be doubted. But this progress was the secret possession of the highest castes, who had kept themselves more or less apart from ordinary people. Hence the enormous difference between the state of mathematics as revealed in the great priestly and royal edifices and as shown in some specimens of the usage of common life and in commerce.

"In his book on the great pyramid Piazzi Smyth has written much that has been justly criticised, and his numbers and dimensions savor of the ultra-mysterious. On the other hand, his book has done such good service in the way of exact measurement that it may be quoted as an authority. Here, for instance, we find the fact that the sarcophagus of Khufu is in cubic contents, measured on the outside, exactly twice as large as its inner space, a case that shows that in the rational methods of the Egyptians, which they incorporated in their large buildings, a way of solving the problem of the duplication of the cube had already been discovered.

"How was it, now, with the common technical and mechanical calculations? In the Rhind papyrus, translated by Eisenlohr (Leipsic, 1877), we have a collection of practical examples—the ancient Egyptians seem not to have made theoretical deductions from these. In these examples we of the present day find an unfortunate clumsiness. For instance, if one wishes, according to the methods of this papyrus, to find out how many times 7 is contained in 77, he must use the following table of factors of 7:

— 1	7
— 2	14
4	28
— 8	56
16	112, etc.

"Those numbers are marked with dashes whose sum on the right is 77, and the sum of the corresponding numbers on the left is the answer. The ancient Egyptian calculators seem to have used entirely multiples and submultiples of 2. Thus, to divide 19 by 8 the following table of factors was used:

1	8
— 2	16
½	4
—¼	2
—⅛	1

"As $16 + 2 + 1 = 19$, the quotient sought was accordingly $2 + \frac{1}{4} + \frac{1}{8}$, or $2\frac{3}{8}$.

"Fractions with numerators greater than unity seem not to have been employed. It may be imagined then that an x in the numerator of an algebraic equation might drive a popular Egyptian calculator to despair. For the solution of such a simple equation (to us) as $x + \frac{x}{5} = 21$, the Egyptian would have to consult no less than five tables of factors.

"Whenever a fraction occurred whose numerator was greater than unity, it was split into a sum of fractions all of which had unity as numerator. This seems to have a close connection with the arrangement of Egyptian measures. The writer has an Egyptian ell

measure with its divisions into royal and common parts—into feet, spans, and inches. It is noteworthy that the second inch is subdivided into two parts, the third into three, etc., and the sixteenth into sixteen parts, evidently with no other object than to be able to write down a measurement directly in a series of fractions having unity as numerator.

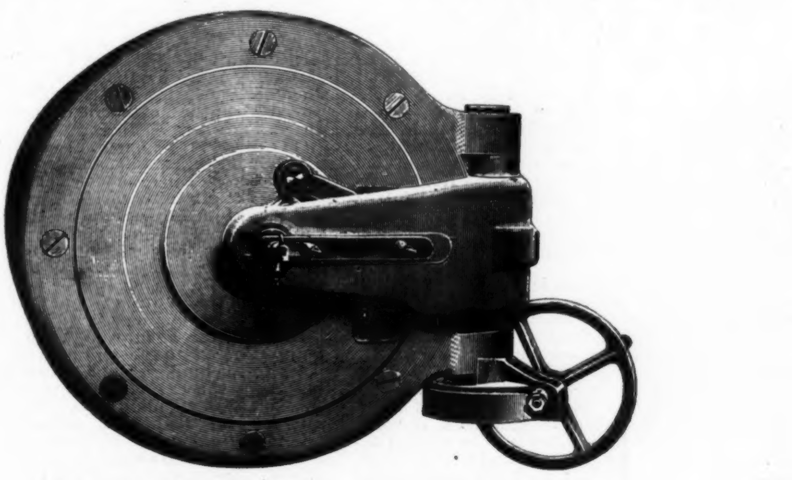
"Still less than the methods of Egyptian numeral arithmetic do their measurements of surfaces correspond to ours; here we meet with actual error. The base of all such measurement with the Egyptian was the rectangle, whose area he correctly gave as the product of two adjacent sides. Now it is either intentional disregard or an inconceivably blind following of traditional method not to take the trouble to ascertain and use the altitude of a parallelogram when its angles are not right angles; but in this case also the area was calculated by multiplying adjacent sides. Naturally this mistake was repeated in the calculation of triangles also; so it came about that the area of an isoscelcs triangle was found by taking half the product of the base by one side. . . . The method by which the Egyptians measured the area of a circle is very interesting; they did this without reference to the ratio of the diameter to the circumference. If the diameter were 18 feet, for instance, the Egyptians subtracted its ninth part, multiplied the remainder by itself, and thus obtained [in this case] 256. We reckon correctly $9 \times 9 \times 3{\cdot}14 +$ [the square of the radius multiplied by the ratio of circumference to diameter], which equals $254{\cdot}34 +$, so the Egyptian error in this case amounted to $1{\cdot}66$.

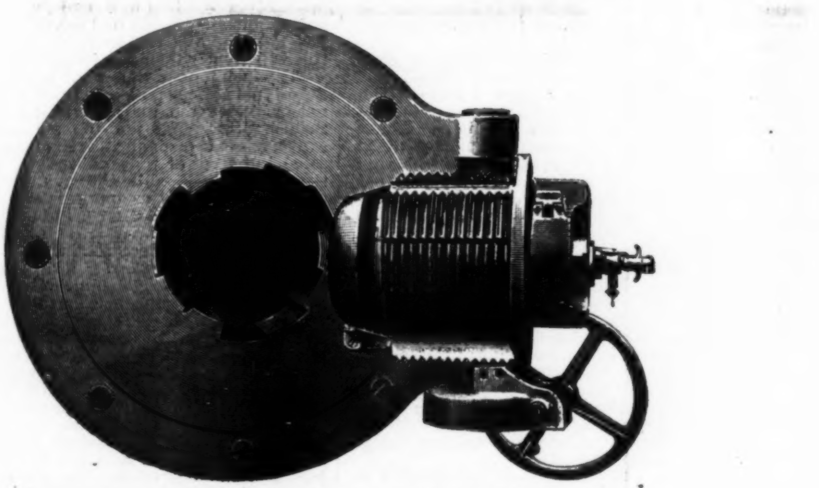
"So much for numerical reckoning as it was needed in the affairs of everyday life. As for the knowledge of geometrical construction, the future may yet reveal to us much of that wisdom which once led its possessors to an unjust pride, to mystery-mongering, and so to formal spoliation of the intellectual property of mankind, by which true knowledge can never be obtained."

NEW BREECH MECHANISM FOR VICKERS' 12-INCH GUN.

WE illustrate herewith the new breech mechanism of the 12-inch breech-loading gun designed and manufactured by Messrs. Vickers, Sons & Maxim, Limited, and now adopted also as the standard weapon by the Woolwich authorities. The mechanism is so arranged that by turning the handwheel the breech plug is first rotated and unlocked and then swung out of the breech of the gun. The unlocking of the breech plug is effected by means of what is commonly known as a toggle joint, the longer arm or link of which has one end fitted on a pin on the face of the breech plug, and the other end is fitted by a pivot joint to the shorter arm or crank mounted in a recess in the carrier on a pivot parallel with the axis of the gun, both the link and the crank thus working in a plane parallel to the face of the breech. Round the boss of the crank are formed "skew gear" teeth, engaging into similar teeth formed partly round the boss of an intermediate quadrant pinion, which is also mounted in the carrier, but on a vertical pivot. This intermediate quadrant pinion has also formed partly round the boss ordinary spur teeth, which engage with similar teeth on an actuating quadrant pinion fixed on the hinge bolt of the carrier. The hinge bolt, together with the actuating pinion, is revolved by means of a worm and a wormwheel, which are in turn actuated by a handwheel suitably mounted at the breech of the gun.

To open the breech the handwheel is rotated, and thus, by means of the wormwheel, the actuating pinion causes the intermediate quadrant and crank to turn, thus rotating the breech plug until it becomes unlocked. By continued turning of the handwheel, the carrier with the breech plug is swung out clear of the breech of the gun. The ordinary retaining catch is employed for holding the plug in position when out of the gun. The opposite action takes place on closing the breech. The gun is arranged for firing by electric or percussion tubes, and its action is similar to that of the 6-inch quick firing gun. A cam in the crank, acting upon the firing gear slide during the first turning of the handwheel, when unlocking the breech, makes the gun absolutely safe before the breech-plug commences to unscrew, and by the continued movement of the crank-cam, the empty tube or primer is automatically ejected.—We are indebted to Engineering for the engravings and article.





NEW BREECH MECHANISM FOR VICKERS' 12-INCH GUN.

LIQUID FUEL.*

By Sir MARCUS SAMUEL.

THE subject of liquid fuel, although now coming into great prominence in England, is by no means a novel one. Russian petroleum has been in use for this purpose, both in Russia and America, for very many years. Its advantages, compared with coal, are well known and appreciated, and the sole obstacle to its universal adoption has been that the supply has been insufficient hitherto to warrant arrangements being made, except in Russia itself, for its use.

In a paper of this kind, it can hardly be inappropriate to touch for a moment upon the nature of petroleum. No experts have yet been able to define how petroleum is or has been produced, whether it is recuperated by nature as it is drawn off, or whether, as would appear from experience obtained in the Pennsylvania fields, and in a region very far from this, namely, the Langkat territory, the yield decreases, and ceases entirely after a time. Where experts disagree, it will be admitted that it is most difficult for an ordinary layman to express an opinion that carries any weight, and, until much greater experience has been obtained, those who handle petroleum must resign themselves to the fact that territories differ almost as much as individuals do; and that while on some it is undoubted that the yield ceases after a time, on others it would almost appear that nature recuperates, and wells which have apparently been exhausted, have yielded their treasures of oil again. At least, this has been the experience in some of the Russian territories.

Again, oil would appear to be found in layers, much below one another, the force and the pressure of gas increasing with the depth attained by boring, and it is no uncommon thing in putting down an oil well to go through strata which might have yielded a fair flow of oil, to case them off, and at some hundreds of feet deeper, to hit upon a flow which has spouted 50 to 60 feet above the derricks, and in spite of all attempts to cap the fountain, a vast escape of oil has taken place.

The surface indications of the existence of oil in a given territory are by no means uniform. In the fields of Baku, nothing but arid sand is to be seen. In Pennsylvania the oil fields are among the richest pasture land, while in Borneo thick jungle has had to be cleared before boring could be commenced. The two pictures shown illustrate a well at Baku and one in Borneo. The former shows a spouting well, and is an apt illustration of the instance I have cited.

The subject is such a large one, that I find I must not dwell at too great a length upon the preliminary stage of formation and production, yet, had these facts not been very recently brought to my notice, I should not have felt either justified or able to prepare the paper which it is now my privilege to read.

The incidents that I have just narrated have actually occurred in the oil fields which the "Shell" Transport and Trading Company, Limited, are developing in Borneo. It was intended, when the exploration of these fields (situated in the Sultanate of Kotei, and under the jurisdiction of the Dutch government) was undertaken, to explore for oil, which, had it proved of a similar description to that found in Sumatra, would have been specially adapted for illuminating purposes, and I must, therefore, frankly state that the discovery of liquid fuel in the enormous quantities in which it has been found in these fields was the result rather of chance than of skill. The very first well bored yielded a supply of oil of a character which showed that, with very little treating, it was an ideal fuel. But the mere production of oil is almost its least value and least interesting state. Markets have to be found, and in this case almost had to be created, because it is a well-known axiom in business that "Nothing sells itself," and the instance is well authenticated of a man who won a wager, undertaking to stand at the corner of London Bridge and offer sovereigns for pennies without finding takers for them. So it is with every commodity which is first brought into use. Prejudices have to be overcome, the means of using treasures have to be shown and proved, and in such an article as liquid fuel, not only has transport got to be provided, but special arrangements for storage have to be made, and it was also obvious that, if practical success was to be obtained, liquid fuel would have to be sold at a price which would enable it to compete with coal. Ab initio this should be easy, when the cost of labor in mining for coal is taken into account, together with its transport from the fields where it is found to a place of shipment, and also the great cost incurred in placing it on board and discharging it, and the space occupied by it in the hold of a ship (this being about 45 feet to a ton of 20 cwt.), and little as this is known and realized, the danger of transport arising from the highly inflammable gases contained in Eastern coals, renders fires in holds and bunkers far more numerous than the public are at all aware of.

It is, of course, impossible to transport oil in bulk in steamers built for ordinary merchandise. Special arrangements have to be made by which the cargo is broken up into sections fixed by the regulations of the Suez Canal as not exceeding 400 tons in any one compartment. It may not be out of place for me to recount as the pioneer, and even, up to the present, the only exporter of oil in bulk through the Suez Canal, the great difficulties which had to be overcome in starting the transport of oil in bulk. Owing to interested and bitter opposition, almost years elapsed before regulations were framed under which steamers carrying oil in bulk were allowed through the Suez Canal at all, and there was not a single port to which we wished to introduce it, but obstacles, more or less formidable, had to be surmounted. In almost every case special regulations were devised to control what was looked upon as a very dangerous trade, yet I am happy to say that though the business has been conducted for now over seven years, not a single accident of any kind has happened, either to a ship while engaged in carrying oil, or to an installation. The picture now shown gives the internal arrangements of an oil steamer specially constructed to the canal regulations. The section shows the arrangements made by the construction of coffer-dams fore and aft for isolating the oil against danger from the boilers or furnaces, which, it will be observed, in these ships are placed quite in the after part of the vessel—a practice which it is a pity is not adopted in more steamers, because the risk of accident from the breakage of the shaft is almost non-existent in this form of structure, the lead being a small one, and the shaft being under the constant observation of the engineers, since there is no tunnel. Under the regulations of the Canal Company, pumps are provided which are capable of a minimum discharge of 506 tons of oil per hour, the pumps in the ship shown being capable, in actual practice, of delivering an even larger quantity than this. To show the progress of the business, I may state that the first steamer employed in the business of transporting oil in bulk through the Suez Canal was a vessel of 4,000 tons burden of oil, while the largest of those employed now carry 6,500 tons, and we have three steamers in course of construction to carry 9,000 tons of oil each, or 3,000,000 gallons.

We must realize that the conditions in the production and transport of oil are different to those of coal. When once a well is drilled, oil flows without any further labor. It is pumped through pipes from the well to the place of shipment, and thence into the ship, and it is discharged in exactly the same manner, not a single human being but the pump man being visible; and in this connection a very curious incident arose. When the first tank steamer arrived in China, the curiosity of the native laborers was very much aroused when they were told that a steamer bringing something like 1,500,000 gallons of oil would be discharged from the ship without a single laborer being employed, and this in the space of forty-eight hours. Some thousands of Chinese gathered along the wharf where the steamer was lying, and astonishment of the most intense description was depicted upon their usually phlegmatic faces. The ship rapidly rose out of the water as the oil was pumped on shore through the pipes, and the manager of the wharf, accosting a Chinaman, asked him what he thought of it. "Well," said the Chinaman, "I can't make it out at all. Nobody pushes, nobody pulls, but the cargo is discharged like mad all the same," and this is, in fact, what would strike an ordinary observer in the handling of liquid fuel in bulk.

The facilities for landing and handling oil necessarily differ very much at various ports. The surroundings, too, of the tanks are essentially different, many being placed amid scenes of natural beauty, with deep

* Paper read before the Society of Arts.

water right up to the walls of the embankment, such as Nagasaki, Japan, a picture of which I now show, where it will be seen nature admits of the steamer lying next to the wharf, while in the next picture I show the installation at Kobe, Japan, where a pier had to be constructed, it being impossible for a steamer to get alongside. The next illustration shows the port of Madras, where a breakwater of almost a mile in length has been constructed before water sufficiently deep to allow a steamer to get near of the size employed in this trade could be found, and even then, as the picture shows, a contrivance had to be constructed to connect the discharging pipe of the steamer with the breakwater. In spite, however, of these drawbacks, it is found that a steamer can easily discharge into the tanks, placed at one mile distant from the ships, at the rate of fully 200 tons an hour. I should also like to show a picture of the island of Freshwater, where the business for Singapore is conducted. The government, not understanding how free the business was from danger, would not allow the tanks to be erected on the island of Singapore itself, and compelled us to go to the picturesque spot shown; and, as a final example of the progress of liberal ideas, I show the installation at Bombay, where permission to land the oil was only given some two years ago, and after experience had shown the immunity from danger attending the transport of oil in bulk, and it will be seen that these tanks are placed almost in the middle of the shipping, railway sidings have been taken right up to them, whence oil is pumped into the tank wagons for conveyance all over India. I will show a train of tank wagons, specially constructed for the India service, and these are very interesting, inasmuch as they are the only tank wagons which are entirely welded by electricity, and not a single rivet is employed in them. This picture shows the bodies of the wagons ready for shipment. The next shows a wagon completed, as used actually in India, covered by a corrugated iron sheet, allowing air to freely circulate round the tank and so protect it from the effects of the sun. To complete the history, I show an up-country station at Ranaghat in India, and some bullock carts, showing how oil is distributed to the shops at Colombo.

It is necessary to go into these details in order that it may be understood what an enormous future lies before this fuel, even if it only depended upon its relative cost compared with coal; but when we come to the collateral advantages it enjoys, the benefits of using it, as compared with coal, are simply overwhelming.

It is unfortunate that it should be so, but one cannot fail to recognize the fact that the calls for purposes of war must take priority of those of peace, and the first great advantage to vessels of war, especially to torpedo boats, in using liquid fuel, as compared with even the best coal, is the entire absence of smoke arising from its employment. When combustion is complete, not a trace of smoke issues from the funnel of a vessel using it. How important this is to torpedo boats the least initiated can understand, but it is not less so to cruisers, or even to battleships, which, when using liquid fuel, could shadow an enemy's fleet without being detected.

I show, in this connection, a picture of the steamship "Trigonia." In September last, the "Haliotis," a sister to this steamer, was brought round from her port of construction (Newcastle-on-Tyne, where she was built by Messrs. Armstrong & Company) to the Thames for exhibition purposes, her furnaces being fitted with an arrangement for burning liquid fuel. They are, however, available for coal in the ordinary way, if required, it being possible to make the necessary alterations for a change of fuel in a very few hours. From the bunkers, which are so constructed that they can be used for either oil or coal, the oil is pumped to a service tank above the boilers, whence it flows by gravity to a device at the furnace doors, where, by means of a steam jet, it is pulverized or broken into spray. The diagrams now shown will illustrate the arrangements made for the utilization of oil by this system, and I might say that a vast field is open for the ingenuity of engineers for devising other methods for the utilization of oil—in fact, almost daily discoveries are being made of means by which liquid fuel may be utilized to greater advantage than any yet discovered, and it would surprise me very much if, with practice, the methods employed do not continually improve. Under the system adopted in this ship, steam is used to spray the oil, but this is certainly not the most economical method, and already a system has been found, invented by a Dutchman, called the Kloos system, which entirely dispenses with the use of steam. The diagrams now shown will illustrate this system.

One main point of difference between the burning of coal and liquid fuel is that, while coal remains quietly in its place until it is burnt, liquid fuel would offer too small a surface to the air when lying in a tank to burn with so much heat as is required. It has, therefore, to be sprayed out in small particles to augment its surface. If, however, the oil is sprayed mechanically, the rush of cold air chills the spray, and many of the small drops reach the funnel before combustion has taken place, thus producing smoke and soot. By heating the air well above the burning temperature of the oil, before it reaches the spray, this is remedied, and combustion takes place freely.

In the heated air system, the oil is forced at about 50 pounds pressure through a Körting's sprayer into the furnace. In this sprayer the current of oil has to pass a screw thread, which gives a rapid turning motion to it, so that the centrifugal force causes the liquid to fly out in dust. The air is brought by a guiding plate at the back of the furnace, returns along cast iron ribbed plates which are heated by the flames above it, and meets rectangularly the current of fine sprayed-out oil, the air being heated to about 500° F. As the hole in the sprayer through which the oil is injected is under $\frac{1}{16}$ of an inch in diameter, the liquid must be well filtered, and to assist the centrifugal force in spraying it out in fine particles, the oil is heated to about 220° F.

I am well aware that it is alleged, as a drawback to its use in the British navy, that liquid fuel has, so far, only been produced in Russia and America, but the territories in Borneo are under the flag of a nation that has ever been friendly to Great Britain, and is scarcely likely to be hostile, and, at all events, provided ample storage arrangements are made, such a stock of liquid fuel could be provided in our Eastern ports as to render the naval authorities practically independent of renewed supplies if, unhappily, hostilities broke out. Neither must the fact be lost sight of that, if oil has been found in the Dutch Indies, there is no reason why it should not be found, too, in territory under British rule. The production in Burma is already of an important character, and, as in most things, we shall see the demand create the supply.

Experiments have demonstrated that the calorific power of oil is almost as two to one compared with Eastern coals. This is in ordinary marine boilers, but in launches the economy in its use is very much greater, and in one craft, used in Hongkong, repeated and carefully checked tests have shown that, while the consumption of coal was 7 pounds per minute, the consumption of oil was only 2 pounds per minute. The pressure of steam realized by 7 pounds of coal was from 96 to 105 pounds, while that raised by 2 pounds of oil was sustained at 116 to 120 pounds. The speed realized in the launch under coal had never exceeded 9 knots, while under oil a speed of 10¼ knots was readily maintained.

It is well known that for locomotives great advantages are experienced in using liquid fuel as compared with coal, and the economy is equivalent to the ratio of 1 ton of oil to 2¼ tons of coal, and, in addition, it has been found that, while a locomotive burning oil will maintain the same head of speed up the steepest gradients, the same feat cannot be accomplished upon coal, where the mere firing of the boiler with every renewal of fuel serves to damp the furnace, whereas every injection of oil, going into immediate combustion, tends to raise and maintain the speed.

One of the first men in England to recognize the great advantage of using liquid fuel on locomotives was Mr. Holden, the engineer of the Great Eastern Railway Company, on which line, in spite of the cost of liquid fuel compared with coal, most of the express trains are run by that fuel to-day. The diagrams shown illustrate this system, which is the best for this purpose yet invented, and by its means steam is readily obtained upon every description of boiler. The next diagram shows its application to a Lancashire boiler, which form is still a favorite among mill and factory owners, and the adaptation of the Holden system to this type of boiler has been very successful. I believe a great future exists for this fuel in smelting works for metallurgical purposes—the intense heat which it is capable of generating, reducing the most stubborn ores.

Great economy is effected also in the stowage of oil compared with coal. We have found, from careful experiment, that the Borneo oil stows in a space of only 38 feet to the ton, and deductions from the figures which I have furnished, as compared with coal, will show the much longer duration of supply in a given space of liquid fuel than of coal, and the consequent less frequent stoppages for filling tenders, or of transporting to them the respective fuels, since it is manifest that if oil is used, only one ton is to be carried up-country, as against at least two tons and a half of coal. I cannot help thinking what enormous possibilities develop in countries where coal is at famine price, as on the projected line from Cairo to the Cape, through the introduction of liquid fuel.

In this connection, and as showing the great progress that has already been made in the use of liquid fuel and its widespread application, I show a slide which represents a later express engine of the Great Eastern Railway, designed by Mr. Holden last year. It has drivers 7 feet diameter and cylinders 18½ inches by 26 inches, and a boiler with 1,292 square feet of heating surface and a working pressure of 160 pounds per square inch. The tender, it will be noticed, is of a particularly neat design, and is capable of carrying 2,790 gallons of water, 715 gallons of liquid fuel, and 30 cwt. of coal. It is provided with a water scoop for replenishing the tank while running. The total weights in running order are: Engine, 49¼ tons, and tender, 36 tons, total, 85¼ tons. The oil firing arrangements embody a number of ingenious details; among them the supply of hot air for combustion from a series of cast iron heaters placed around the inside of the smokebox, the air being drawn from the front through the heaters to the burners by the exhausting action of the steam jets used for injecting the oil fuel. The latter is warmed before leaving the tender in a cylindrical heating chamber, through which the exhaust steam from the air brake pump circulates.

The next slide shows the foot plate and interior of the cab of one of these engines. The regulation of the oil supply is effected by a neatly designed gear attached to the cover or hood of the ordinary fire door. These engines have been specially constructed for running the fast Cromer service, on which they have rendered a good account of themselves during last summer.

The slide now shown represents a small four-coupled shunting engine, of the London and Northwestern Railway, fired with oil fuel on Mr. Holden's system. It carries the oil below the foot plate in a long reservoir, from whence the burner lifts it by suction. Engines of this type are used in the Liverpool docks.

Next is an engine of the Metropolitan Railway for service on the Underground in London.

One of the suburban engines of the Western of France is shown in the next slide. It is working between Paris (St. Lazare) and St. Germain.

The succeeding picture shows the Vienna to Paris express, with a heavy Goldsdorf compound engine in front, burning oil fuel on Holden's patent system. The train is shown standing at St. Anton, just prior to entering the Arlberg tunnel, six miles long. All trains, goods and passenger, passing through the tunnel are now fired with oil fuel on Holden's system.

I have now a view of the Coronado express of the Southern California Railway standing at San Diego, with an oil burning locomotive in front. Oil fuel is now the common fuel in South California, immense deposits being worked at Los Angeles.

The next slide shows a winding plant for mining machinery with portable locomotive type boiler fired with oil. This fuel was adopted here on account of the cost of transport, only one ton of oil being carried instead of two tons of coal.

The last slide shows a traction engine, 40 indicated horse power, for South Africa, running between Umtalia and Salisbury, burning oil fuel. Coal being expensive, and wood scarce, oil fuel has been used here.

Nothing can give a better indication than these slides of the widespread use that liquid fuel has already attained, and it is quite clear that in countries where it can be put down, as it can unquestionably now from Borneo to all ports east of the Suez Canal, at prices which will enable it to successfully compete with coal, its use is quite certain, and that in the immediate future.

The advantages of the use of liquid fuel in steamers, however, are even more manifest than in its employment on land. None but those concerned in the actual management of steamers know what trouble and anxiety arises from the employment of what is known as the "black element," namely, the stokers. By the use of liquid fuel the services of these men are almost entirely dispensed with, because oil flows by gravitation from service tanks placed well above the boilers, direct to the furnaces. The expansion and contraction caused by the frequent opening of the furnace doors is entirely avoided, and the life of a boiler, consequently, greatly prolonged. No ashes are made, and the strain and distress to firemen of heaving these overboard before commencing their watch is entirely saved, and no grit (so deadly in its working to delicate parts of the engines) is created. I fear it is only a practical expert who will realize how much this means.

To anyone who has seen the almost inhuman manner in which the large crew needed on a torpedo boat or destroyer are berthed, in consequence of having to stoke the enormous boilers used upon these craft, the fact that under the use of liquid fuel the crews of these vessels can be reduced to less than half of those now necessary is, in itself, an argument so overwhelming that, were this its only advantage, it would suffice to compel its introduction into this class of vessel by those in power; but, when it is borne in mind that men in torpedo craft literally carry their lives in their hands, depending solely on the speed of the vessel, and not upon her armament, it is clear that a great step is attained when the crew carried upon these vessels is reduced.

Oil can be carried in spaces which it is impossible to utilize in any other way, and especially in such craft as torpedo boats, where the form of the vessel under water renders the attaining of stability a difficult problem. Oil carried in the bottom of the steamer below the waterline would be impervious to shot, and, by the system of service tanks patented by Sir Fortescue Flannery, as oil is pumped out of the ballast tanks of a steamer, water can readily be taken in to replace it, because if the mixture is put into a service tank and allowed to settle, water is quickly precipitated to the bottom and can be drawn off, the oil remaining being pumped pure into the second service tank, whence it flows to the bunkers; and it can readily be conceived how many spaces now lost in vessels can be utilized for the storage of oil, allowing a much greater weight for armament or quantity of cargo to be carried in space now used for bunker purposes only, or lost entirely through being too small or inaccessible for the storage of coal. The importance of the new departure has been promptly recognized by Lloyds, who have issued regulations allowing liquid fuel having a flash point of over 200° Fah. to be carried in steamers' ballast tanks, and this will greatly facilitate its general use.

The much longer time that a vessel equipped with liquid fuel can keep at sea is also a factor which must not be overlooked, and, provided relays of supplies are furnished at ports not too far apart, the carrying capacity of an ordinary merchantman is increased by some hundreds of tons, dependent necessarily on the size of the vessel, while the saving in time in taking in oil instead of coal as bunkers can be best estimated when I state that oil can easily be put on board at the rate of 300 tons per hour, and this without the slightest dirt, a great characteristic of the Borneo oil being, too, that it is almost odorless.

The experimental stage in the burning of liquid fuel, as stated at the commencement of this paper, has long since been passed. The uses for it in Russia itself are innumerable, and the latest statistics show that no less than 7,000,000 tons per annum are consumed in Russia for liquid fuel alone. Lately it has been largely adopted for naval purposes as well, while for many years the steamers navigating the Caspian Sea have used it exclusively. There are no less than eight steamers at present engaged in the Eastern trade which are fitted for it, and the results attained have answered the expectations of their owners beyond their most sanguine anticipations, while large numbers of vessels are under construction expressly for the use of liquid fuel, and a great number of steamers hitherto burning coal are also being altered. In the far East tanks have been erected at ports ranging from Yokohama to Suez, including all the Indian ports, while cargoes of the Borneo oil have also been landed at the principal ports and 4,000 tons is on passage to London. Under the advantages which I have enumerated, it will be understood that it is rapidly going into general consumption. In Europe the Russian, the Italian, and the German navies have partially adopted it, and it will be a curious circumstance if, with the great engineering skill available in the British navy, our naval authorities should not also see their way to use it to advantage in the immediate future.

FIRE TESTING STATION.

THE British Fire Prevention Committee, founded by Mr. Edwin O. Sachs, after the Cripplegate fire, to promote the purposes generally indicated by its name, has established on the banks of the Regent's Canal, near St. John's Wood Road Station, a fire testing station, which was formally opened on February 1.

The object of the testing station is to obtain reliable data as to the exact fire resistance of the various materials, systems of construction, or appliances used in building practice. Such data have not as yet been available, owing to the fact that nearly all investigations of this description have been carried out by individual makers or inventors with specific commercial objects in view. The few independent tests made in the United States have so far only been of minor importance. The series now to be undertaken by the committee will not only fulfill a long-felt want for the professional man, but be the first of their kind. The fire-

proofing trades, too, will at last be able to obtain authenticated records which will hall-mark their work.

The testing station comprises two houses standing in their own grounds near Regent's Park, and backing on to the Regent's Canal. The principal building will be used for committee rooms and laboratory purposes, while the gardens are utilized for the principal so-called "full-size" tests. These are generally carried on in brick chambers specially erected for the purpose. The fuel primarily takes the form of gas, and the principal recording instruments are electrical pyrometers with photographic records, the ordinary photograph camera, and the smelting globule.

The recording instruments are from the design of Sir Roberts-Austen, of the Royal Mint. The gas installation has been supplied by Messrs. W. F. Mason, Limited, of Salford. The mains are from Messrs. Laidlaw, Glasgow. The steam plant and fire appliances are from Messrs. Shand, Mason & Company, Limited, London.

As to the financial aspect of the station, the establishment expenses have been met by a special subscription, which will also cover the expense of conducting tests of general technical interest. Tests with patented materials, makers' systems, etc., are, however, subject to a scale of charges, but these charges are so figured as to only just cover the actual cost. The services of the members conducting or attending tests are given gratuitously.

THE LOGICAL ARRANGEMENT OF THE MOTIVE POWER OF WARSHIPS.*

By GEORGE W. MELVILLE, Engineer-in-Chief U. S. Navy.

IN the preparation of a set of tables showing the power required to drive a vessel of a given displacement at a given speed, data have been used which were gathered from the results of about two hundred trials of nearly as many ships. From this set of tables there was developed the remarkable fact that the propulsive efficiency of vessels with three screws is, in almost every case, above that of ships of approximately the same size, speed, and general lines, but fitted with but two sets of engines. Attention has heretofore been drawn to the remarkable performance of the U. S. cruisers "Columbia" and "Minneapolis" on their trials. Recently, as the number of high speed ships has increased so greatly, it has been very interesting to those who were responsible for the plans of the machinery of these vessels how well they have maintained their position in the front rank of all naval vessels. These five-year-old ships, ten years old in design, are still among the most economical vessels in the world's navies so far as propulsive efficiency goes.

There are many reasons for the superiority of the "Columbia" and "Minneapolis" over other vessels of the United States navy built at about the same time. The stream lines of these vessels are remarkably easy and the resistance is low, these factors giving—it is claimed by many—a total resistance below that calculated from results of trials of less carefully designed ships. This is no doubt true to a certain extent, but comparison between these American ships and those of other nationality, but of approximately the same lines and speed, shows still the superior efficiency of these vessels. The main cause of this increased efficiency lies in the use of three engines and propellers for the motive power. Not only has the propulsive efficiency been benefited, but there are so many engineering and tactical advantages arising from the use of triple screws that it may be readily seen why so many ships are now designed for this system of propulsion.

The advantages due to the use of three propelling engines instead of two have been pointed out before, but it may be of interest to recall some of the reasons leading to the adoption of this system for the "Columbia" and "Minneapolis." It was not possible, at the time of the design of these vessels, to obtain, in the United States, sufficiently large forgings for such great power as it was desired to install, if the twin screw system were adhered to. Other chief factors were the greater safety of the machinery and of the ship due to the use of three screws, as well as the, then conjectured but now proved, increased economy due to the use of triple screws.

To-day we have a somewhat different case presented in the design of high powered cruisers or battleships. The conditions have changed. We are confronted no longer by the probable inability of the steel manufacturers to furnish forgings and castings of any size we may desire for any power yet designed to be installed in a man-of-war. On the contrary, we have examples of engines of about the power we desire to use for our fastest ships already constructed in the United States and giving complete satisfaction, not only to the designers but also to the builders and to the owners. The science of metallurgy has made such progress in the last decade that we are now able to specify regularly steel of 95,000 pounds tensile strength, 21 per cent. elongation in 2 inches, and to stand cold bending to an inner diameter of 1 inch without showing cracks or flaws. Improved methods of forging, our more thorough knowledge of fluxes, the exclusive use of nickel steel for high grade engine construction, the judicious employment of annealing and tempering—all these, combined, enable us to secure stronger materials, and now we obtain a vast increase of power without a much greater weight than that required, ten years ago, for the lower powers then prevailing. The reduction in weights is most apparent in the moving parts. This is an important point, as it has meant that the growth in power has not been accompanied by an increase in vibration—a matter that is likely to limit speeds of rotation in the future. We are no longer forced to divide the power among three shafts because of the impossibility of obtaining one sufficiently large to transmit half the power. We can now secure in the home market all of the materials needed for the machinery of the highest power yet planned.

There are many other considerations, however, both tactical and engineering, which make it still advisable, at least for the highest powers, to use the triple screw method of propulsion for our men-of-war.

The most evident advantage from the use of three screws is the consequent subdivision of the power. This is of particular moment on war vessels, where the possibility of disaster in battle is to be considered as well as that of accident in time of peace. Not only does the increased number of engines decrease the probable amount of power that may be disabled at any time, but also the chance of fatal injury to the ship, through its motive machinery, is lessened greatly. The danger from a shell is decreased. It would require three shots penetrating the steel deck to completely disable a triple screw ship, as against but two in the case of a vessel fitted with twin engines. This, however, is assuming a possibility which may not be a fact, that a shell will not have any disastrous effect outside of the compartment in which it explodes. It is probable that the vertical bulkhead between the engine rooms cannot be so entirely depended upon as to restrict the effects of an explosion. It is quite possible that a single very lucky shot might disable completely a twin screw war vessel. If so, then it would take at least two such shots to inflict corresponding injury on any ship with triple screws. In case of the wrecking of any single engine, the amount of power lost with twin screws would be one-half, as against the much less reduction of one-third in triple screw ships.

It may be urged, and with justice, that the engines of our men-of-war are already well guarded from shell fire. If it can be shown, however, that the protection can be increased without consequent loss in other directions, it will surely be well worth while to adopt the system affording greater security. In the old days of sailing ships many a battle was won, sometimes against superior force, by the disablement of the sail power of one of the combatants. After the motive force of any fighting ship was gone she was at the mercy of her foe.

In our time, when battleships have a fair all-around fire, the likelihood of this is somewhat reduced; but it is still apparent that any ship which is inert upon the sea is far the inferior of her dirigible enemy. Any system which increases the chance of securing and keeping the "weather gage" in battle must be good.

Should one of the propelling engines be disabled, there is not nearly as much interference with what is called the handiness, the steering qualities, of the ship, if there are three screws, as if there be but two. With twin screws, and one only in use, it is necessary, in order to keep the vessel on her course, to use a helm angle of from 6½ to 10 degrees. This is the amount when the screw of the idle engine is left to revolve freely. We have attempted to get over this difficulty by using diverging shafts and thus reducing the turning effect of the engines, but this is objected to by the deck officers who wish vessels which can readily "turn on their heels." Of course, the less the fraction of the power that is disabled, the less the ill effect on handiness.

For war vessels it is desirable to make the watertight compartments as small as possible. The reduction in the smaller sizes of engines in three-screwed ships leads to this end, and, as will be pointed out later, this is effected with no increase in the total engine-room space.

One of the greatest advantages from the use of triple screws is that smaller propellers are required for the same total power. This particular in itself presents sufficient advantages to justify the use of three engines on war ships, advantages which are so practical, engineering and tactical, that it is surprising that this point has not been more thoroughly developed.

A very large part of the loss of power at the propeller is due to the frictional resistance of the water to the passage of the propeller blade. This resistance increases with any increase of the peripheral speed of the blades, and low speed will be advantageous in this regard. It is assumed, of course, that due account is taken of the ratio between the pitch and the diameter of the screw. If this ratio be not unreasonably increased, however—and with the large hubs used in current designs this ratio may be profitably rather high—it will be a great gain from an economical standpoint to reduce the peripheral speed. With very high speeds and powers this speed is now very near the critical point beyond which the friction is excessive, and the effects of cavitation begin to be felt. The decrease of pressure upon the forward sides of the screw blades, at high velocity, is not a negligible quantity. The matter of proper propeller design is too complicated to be more than glanced at here, but it must be evident that to reduce the peripheral speed would be advantageous in the cases of the screws of large diameter necessary in the application of very high powers.

Now, the use of three screws allows a reduction in diameter of screw of over twenty per cent., and while, as will be pointed out, this is accompanied by an increase in the number of revolutions, the speed of periphery may readily be reduced below what is required in twin screw practice.

At the stern of the ship amidships, in the following wake always present to some extent with the most carefully designed hulls, the effects of a large screw are not so signally bad. I think that cavitation, or the tendency thereto, is greatly reduced in this following wake, and on that account I believe that a considerably greater efficiency is obtained from the screw at the stern post than from those on the quarters. Whatever the cause, this increase in efficiency is so well shown by the results of trials that it can no longer be questioned.

I mean, of course, the trials of large ships, not tank experiments. The latter serve very well for determining the actual resistance of a hull, but not for fixing the economy of propulsion or the ratio between the towing and indicated powers. It is in the increase of efficiency and not in any decrease in resistance that the economical advantage of triple screws must be found.

No test of a propeller can be held to have so much value as a test upon ships. Model experiments of propellers are not satisfactory. It requires experiments with the full sized screw, working at the designed pitch and at its designed speed, under its full load of work, to give us conclusive results. Trials under these conditions show, as I have said, a considerable advantage due to the use of triple screws.

Investigation along this line has not yet proceeded far enough to enable me to give more than tentative figures as to the propulsive efficiency due to the different methods of arranging the screws. It is, however, certain that there are gains from both the use of small screws and of a screw working in the following wake, and that these gains would naturally grow with an increase in speed. Speaking only of full power trials, it will probably be found that, up to some low speed not yet determined, it will be best, from the economical standpoint only, to use a single screw; beyond this point it will be found that the use of twin screws would tend to a reduction in the power required for a given hull and maximum speed, and that, at any time, where twin screws are good, triple screws are better. I estimate the average economy over single screw ships from the use of twin screws as about 8 per cent. for vessels of maximum speeds from 12 to 20 knots, and I consider that triple screws are more economical than twin screws by from 5 per cent. for 15-knot ships to 12 per cent. for those of 24 knots speed. These figures are approximate, but they are from trial data of many ships fitted with the different methods of screw propulsion.

I have discussed this point at considerable length principally to develop the following conclusions:

1st. The use of triple screws leads to a considerable economy at the highest speeds.

2d. Decrease in size of screws is peculiarly economical as regards the wing screws; and

3d. To evenly distribute the ill effects of high peripheral speed, and to take advantage of the following wake, the center screw should be made larger than the wing or side screws.

But there are many other advantages due to the smaller screws, particularly the smaller wing screws, and especially for men-of-war.

In ramming an enemy, if all goes well, there would be little difference between the twin and triple systems, but a glancing blow from either forward or aft would certainly take off the enemy's side screw if, as in twin practice, it projected beyond the counter; and, later on, as the ships rubbed past each other, one's own side screw would be broken under the same condition of projection. But, with a small screw, such as can be had in the triple system, neither propeller would be damaged, and the stern screw would be safe in any event. This point is of value, too, in ordinary cruising where a floating log or a pile in a river would disable a propeller of a twin screw ship, while the obstruction would have been pushed clear of the smaller propeller of a triple screw by the ship's hull. Going alongside dock also—that bugaboo to commanders of high powered, fine lined, speedy twin screw vessels—would be made much easier.

The shorter shafting required for getting the smaller propellers clear of the ship would allow these screws to be placed further forward, where they would be better protected by the hull. This shorter shafting would also decrease the strains on the propeller shafting in bad weather, and would often obviate the necessity of an extra supporting strut, giving, as well, a decreased danger of fracture and the possibility of decreasing the weight.

The fact that with smaller screws the tips of blades are lower in the water than with the twin screw system gives advantages. The design of the upper and fuller stream lines could be considerably freer. If it is considered advisable (and I have no doubt the hull designers will show that this gain is not of great moment where a central screw is fitted), this advantage could be passed over in favor of giving the wing shafting a slight inclination upward, so as to obtain a horizontal thrust when the stern of the vessel settles in the water at full speed. Ordinarily, however, the squatting of the ship would be insignificant. The fact must not be overlooked that the lower propellers are placed, the freer the access of water and the more perfect the action of the screw.

With tips of blades well buried the danger of racing is decreased, each extra foot of immersion reducing it. Any one who has stood by the throttle, checking the engine with the heave of the ship, appreciates fully this advantage. The central screw, of course, would never race except in a sea where the ship was pitching heavily; while the side screws, being well forward and deep in the water, would probably never give trouble in the worst of seas.

When the use of three screws was first proposed, the idea prevailed in the minds of most engineers that the "race" of the water from the side screws would materially affect the action of the central screw. The error of this supposition was fully shown by the trials of the "Columbia" and "Minneapolis." In the "Columbia" the pitch of all screws was made the same. The trials of this ship having shown the revolutions of the central screw to be less than those of the wing screws, the pitch of the central screw on the "Minneapolis" was made 6 inches less than that of the side screws. On the trials of the latter vessel the speed of rotation of the central screw was almost precisely a mean between the speeds of the two side screws, which differed slightly in pitch. This result was obtained without any "jockeying" of the throttle or change in the cut-off.

Attention has been called to the feasibility in the triple system of securing a greater number of revolutions, owing to the reduction in diameter of the propeller giving decreased friction of the blades. This matter of increased speed of rotation affects directly the efficiency of the machinery, especially in warships where the stroke of the engine is limited by the height below the protective deck. The piston speed must be high to get the required power from modern machinery without too cumbrous low pressure cylinders. Any increase in piston speed, or in the number of revolutions, decreases the condensation in the cylinders, as the item of time is one of considerable importance as far as this condensation is concerned. And, further, as a consequence of greater piston speed, we obtain lighter engines and shafting. For small powers, it is generally possible to obtain great piston speed in our low naval engines, by a great number of revolutions; but there has been pointed out the difficulty of obtaining efficient propellers at high rotative speeds, for transmitting great powers. We know, of course, that it is possible to get an efficient propeller for the very highest powers yet used; but these propellers must be of great diameter in large ships, and in the United States we look into the matter of draught very closely. Our vessels are built for entering comparatively shallow harbors, and it is not easy to secure a screw that will be efficient, and that will fit on a 22 knot, 12,000 ton ship of no more than 24 feet draught. There must be a certain minimum immersion of the screw blades, and this must

* Paper read by Harold P. Norton on behalf of the author before the British Institution of Naval Architects.

be greater for twin screw than for single screw vessels, because of the rolling of the ship. It is necessary also to have a considerable difference in level between the keel and the lowest part of the screws in a twin screw vessel. It will surely be difficult, and, I believe, impossible, without the use of high glacis plates, to obtain satisfactory machinery for twin screw ships under the conditions named, 22 knots, 12,000 tons, and 24 feet draught.

In the design of marine machinery it is important that the ratio between the stroke and the diameter of cylinders be kept sufficiently high. This ratio is necessarily low in all naval vessels as compared with the merchant service, on account of the necessity of keeping the machinery below the protective deck. Of course, the larger the power and size of the low pressure cylinder, the longer the stroke should be, and therefore the greater the height of engine room required for a properly designed engine. The greater the draught, the greater the possible height of engine room, and, for the same number of revolutions, the greater the piston speed. It is unquestionable that, where more than, say, 10,000 horse power is to be transmitted through a single shaft, under present conditions of speed and displacement, the number of revolutions will be limited by the propeller. We in the United States navy, having ships of very light draught, as compared with other fleets, are most hampered in this regard.

It has been shown that the use of triple screws would tend to a decrease in the volume of the cylinders required for giving the power. This is quite apart from the fact that the power is divided into three parts instead of two, and is due to the greater piston speed possible with the smaller screws. It will be seen, then, that considerably more latitude is allowable in the design of machinery for ships with triple screws than would be possible if twin screws were used. If three engines are installed, it is certain that a less height is required under the protective deck than would be necessary for a twin screw ship.

It is to be noted, then, that the economy of a triple screw ship is developed not only in more efficient propulsion, but also in the more efficient use of the steam in the engines due to the decreased condensation following the increased number of revolutions and the greater piston speed. The economy of propulsion is thus increased as a result of both increased propulsion efficiency and of increased efficiency of the engines. A decreased total weight of the machinery is also a natural result of the use of triple screws.

It is, of course, a fact that the use of three engines multiplies the number of engine parts. The resulting disadvantage is, however, much more apparent than real. The "Columbia" and "Minneapolis" are examples of the practicability of installing large power in three 3-cylinder engines, and this was accomplished with a stroke of but 42 inches. There is no doubt that it would have been necessary to use 4-cylinder engines at least, if twin screws had been used. The absolutely necessary increase in the number of cylinders is thus shown to be but one-eighth. Of course, it is understood that the use of three-cylinder engines is not now generally approved. It is merely pointed out as feasible, and as intended to show that the arguments against triple screws, based on the multiplicity of engine parts, could readily be made of practically no weight, if other conditions did not render advisable an increase in the number of cylinders.

Watertube boilers have now come to stay, at least as far as the United States navy is concerned. These bring with them steam of high pressure and cause the use of quadruple expansion engines for economy's sake. At 300 pounds pressure the quadruple expansion engine gives sufficient gain to justify its employment. Owing to the low powers of peace cruising with men-of-war, it is questionable whether it is desirable with these ships to design engines for the greatest economy at the highest powers. Unquestionably, an arrangement of cylinders which gives the greatest economy at the highest powers produces a markedly uneconomical engine for the lower powers ordinarily used in peace.

The wide variations in present designs show how different designers view this problem. It is extremely complicated, and I am free to confess that much more data than are now available is needed for a full solution. We must know the cost of running the auxiliary machinery, and not only the average power of the main engines, but their range of power must also be carefully considered. It has been thought advisable, however, in the design we are proposing for our latest fast ships, to use quadruple expansion engines throughout, using 13 cylinders in all in the three main engines. This is a considerable change from the practice of 25 years ago, when two cylinders were most frequent. But the fact that this large number of cylinders has been adopted shows that our experience, at least, is that the argument of the multiplicity of parts of the engines has comparatively little weight. The decrease in the size of parts, with the consequent increase in accessibility, in accuracy of adjustment, and in ease of repairs, is a natural sequence of the growth in the number of parts, and seems sufficient to overcome the disadvantages. It will be pointed out, further, that the increase in the number of working parts due to the use of triple screws is only apparent, as ordinarily there would be not more than eight cylinders employed on our triple screw ships, against ten cylinders that would necessarily be used in the proposed five-cylinder quadruple expansion engines for our twin screw ships.

(To be continued.)

The delicacy of modern measuring instruments was strikingly shown in Prof. Vernon Boys' determination of the density of the earth. The force which he then measured was, he has stated in a recent lecture, equivalent to a weight of 1/12,000,000 of a grain acting at the end of a lever 1 inch long.

The Montreal Street Railway Company has been receiving $200 per month from the Dominion government for allowing letter carriers to use the street cars of the company in the performance of their duties. The company claims to have kept a record of the number carried, which shows that at regular fares the sum to be charged would be over $1,000 per month. In Toronto the price paid is said to be $400 per month.

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50 stitched in paper, or $3.50 bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers, 361 Broadway, New York.

TABLE OF CONTENTS.

1899.

nent.

r.

rs in any
dollars a

from the
l. Price,

can like-
l yearly.
, or $3.50

C AMERI-
SUPPLE-

ents, and

w York.

PAGE

ON

fail to

yearly
of a

EACH.

S!